ENGINEERING 10/5/57

ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 183 No. 4757 *LONDON, FRIDAY, MAY* 10, 1957 PRICE 2s.

TANKER ON THE STOCKS

Nurnberg photograph for ENGINEERING

MAY 10, 1957 VOL. 183 PAGES 577-608

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An Illustrated Weekly Journal

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Published every Friday by Engineering Limited, 35 & 36 Bedford Street, Strand, London, W.C.2
TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663.

Subscription Rates for 12 *months, Inland and Abroad* £5 10*s.*, *Canada* £5 5*s. Subscriptions for periods of less than* 12 *months are based on the price of a single copy including postage* (2*s.* 3*d.*)

LIVING IN

GIVEN proper residential accommodation, undergraduates educate one another. Yet with few exceptions most colleges in Britain are forced to allow more than half their students to live in lodgings or at home. At a time when more engineers and scientists are demanded, so that the universities have had to increase their numbers, little has been done to expand college living accommodation. Despite popular belief, few colleges, even at Oxford and Cambridge, are wealthy to-day and unless benefactors, either private or corporate, come forward with help the colleges will not be able to erect the new buildings that the times demand.

The position varies widely throughout the country. Taking Oxford and Cambridge together, about 52 per cent. of the undergraduates have rooms in colleges at any given time and perhaps 90 per cent. spend at least part of their time living in. At London, 35 per cent. continue to live at home, and another 46 per cent. are forced to search for digs. An average London student spends about an hour (and half-a-crown) travelling each way. If he joins in sports the chances are that his college ground is in the opposite direction and another rail fare away. Contrast these conditions with those at the University College of North Staffordshire founded since the war and providing accommodation for all its students. At Glasgow and Newcastle, on the other hand, many of the students travel to and from their homes daily. History plays a large part in all this. Oxford and Cambridge were ancient foundations and drew their students from the whole country and from overseas. London, beginning early in the Nineteenth Century as a break-away from ecclesiastical domination, also served students from many areas, but in those days students came from wealthier homes and London was not the shambling conurbation it is to-day. The provincial universities were generally built to serve their own areas and their students had short journeys.

The success of Manchester University's appeal for £1 million for residential accommodation shows that there is considerable practical sympathy in industry. At Newcastle, an appeal for funds has been equally successful in reaching the target. Industry has, however, also tended to aggravate the situation by the very generosity of its research studentships, which enable more men to stay longer at the universities. Yet much of the latent value of such studentships is lost if the man does not meet and mix with leaders in faculties other than his own.

Oxford and Cambridge, however, have a particular problem not to be found at the provincial universities. (London is different again.) In the provinces the governing body has power to use any income to the best advantage of the student and is able to strike a balance between the needs of teaching and accommodation, salaries and equipment. At the two older universities the position is somewhat different: the university is the teaching and examining body only while the colleges, quite autonomous, provide the accommodation and the conditions under which a man may learn, principally by association with others who are of a kind and yet of widely differing interests. The University Grants Committee, apportioning the State's money, puts it into the universities, not into the colleges. The result is twofold: undergraduates spend half their time in digs (and with full employment good digs are becoming harder to find) and at Cambridge, for example, less than half the university lecturers are now fellows of colleges. The reduction in the proportion of fellows has two serious consequences. Half the teaching staff is no longer personally associated with the undergraduates and—what is almost more important—the professional contacts of the fellows tend to be confined to their specialised departments instead of the wider community of a college high table where, though everyone is an expert in some field, it is rare that more than two belong to the same faculty.

The proportion of engineers at universities is increasing. Not merely are they increasing in sheer numbers because of Government policy, but the colleges are finding that a much better class of student is now demanding engineering. Even those colleges most addicted to the classics are opening their doors to would-be engineers. But the colleges in London and the provinces, as well as at Oxford and Cambridge, do want money to build accommodation. Not only are more rooms required for undergraduates and fellows, but a new type of accommodation is needed for the engineers and scientists sent back by industry for post-graduate training. Tied to laboratories throughout the year, they have to be fed and housed during vacations as well as normal term time. It is not economical to keep open whole colleges and their kitchens for their small numbers. Separate blocks or hostels are becoming necessary to meet the situation. It would not be very important if the new hostels were some little distance away from the college or university centre. It is important for a sufficient number of students to live together as a college community and not be dispersed at random in ones and twos in inadequate lodgings.

At Oxford a new college, St. Anthony, has come into being, and many colleges have been

able to build new blocks, thanks to the generosity of a Frenchman. Vickers have recently given the Imperial College £1 million to build hostels. Who will do the same for the needy among the Cambridge colleges? And in the provinces, where many of the colleges have already done much to help themselves, will not industry help again in order that the local university may develop to meet the needs of changing times? The problem is vital to industry, for university education in the future depends on the provision of new living accommodation.

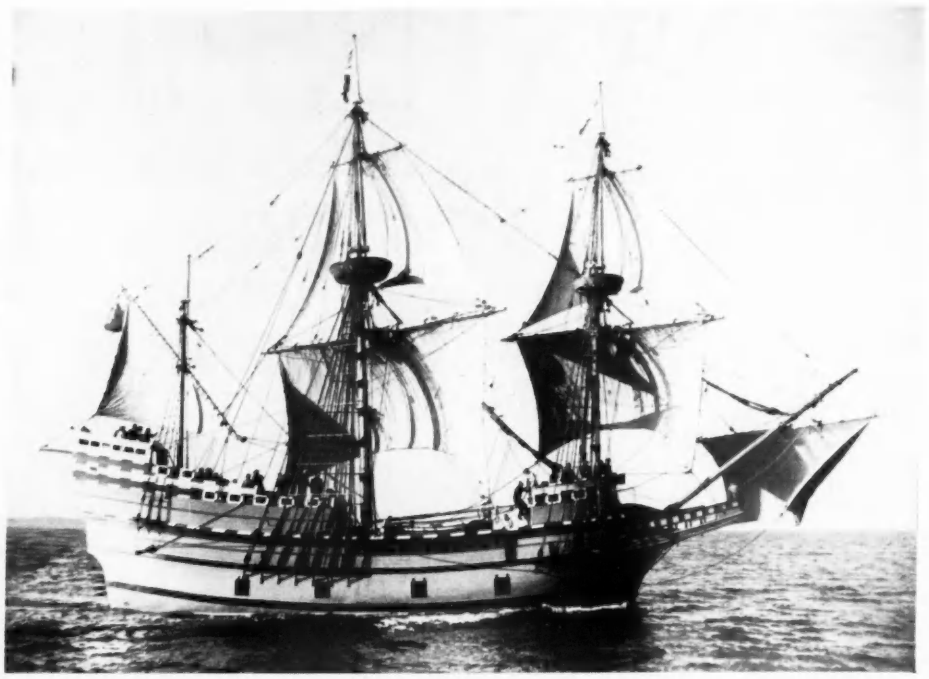
* * *

Plain Words

Worship of the inanimate is quite a harmless pastime when it takes the form of small boys writing down locomotive numbers. Some of its more adult forms are potentially much more dangerous. One of these is the growth of clubs which have been established to develop some sort of social sense among users of certain makes of equipment. These kinds of organisations are usually started by makers of equipment to create a sense of belonging and community of interest among users. In so far as they invoke a sense of pride in an operative's machinery and a desire to see that it is maintained to a high standard of efficiency, the idea is entirely wholesome. Pushed to its logical conclusion it has the makings of tragi-comedy.

Clubs of this sort owe much of their initial drive to a selling idea. Men who develop a feeling of pride and ownership in a mechanism will not readily change to another type and they can be relied upon to extol the virtues of the equipment they drive or operate. Inevitably there must build up a body of hostility to change on the shop-floor level. Those who get in first with such an idea have a selling advantage but, in the end, all operatives may belong to one club or another and all may resist change. What started as a selling stunt (admittedly with some very worthwhile advantages from a social point of view) may end as a salesman's nightmare.

It is indeed possible to envisage strikes on matters of this kind. How far will management be prepared to force a new machine on an organised group dedicated by ties of loyalty and group instinct to an old-fashioned device on the shop floor? Who is the salesman to sell to? When he has sold his product to the management, must he go downstairs and sell it to the "club"? What kind of petty power politics might develop between the shop stewards who have a man's allegiance on union matters and the "club" officials who can evoke loyalty to the equipment? Is the loyalty to the equipment to be exploited to achieve sales? In addition to the merits claimed for the machine is it also to be sold as "equipment to be proud of" with special devices for the comfort and showmanship of the operative? These are some of the questions which might have to be answered if this kind of thing is pushed too far. They offer comedy with some grim implications.



The "Mayflower II" carries only six sails—main and fore courses, main and fore topsails, lateen sail and rectangular spritsail.

THE "MAYFLOWER II"

The sailing of the Mayflower II, now on her way across the Atlantic to re-enact, after 337 years, the voyage of the Pilgrim Fathers in the original Mayflower to Plymouth, Massachusetts, is the culmination of a scheme which has been slowly coming to fruition for some ten years. The "Mayflower Project," as it has become known, originated with Mr. Warwick Charlton, of London, who recruited influential support for it in Britain, where the necessary funds were raised, and attracted much enthusiasm in the New England States, where the voyagers are assured of a much more friendly reception than was ever enjoyed by the Pilgrim Fathers themselves.

Technically, however, the design and construction of the Mayflower II perhaps offers a more permanent interest than the actual crossing, for the task which confronted her designer, Mr. William A. Baker, naval architect, of Hingham, Massachusetts, in attempting to create a vessel which should be, as nearly as possible, a duplicate of the original Mayflower, presented exceptional difficulties. The chief of these was the initial handicap that practically nothing was known about the original ship. The diary of Governor William Bradford—erroneously described in one popular reference book as "the MS. log of the Mayflower," and the chief source of information about the expedition itself—does not even mention the ship's name or that of her master, but merely states that her "burden" was "nine score"; presumably tons (or, in that day, "tuns"), though even this is no more than an assumption.

Such drawings of contemporary ships as were available were mostly of warships and were only moderately helpful; for, though externally and in rig there might be an apparent similarity between a warship and a merchant ship of the period, the interior arrangements would probably be different. Also, the Mayflower was almost certainly an old ship, not necessarily representative of the best contemporary practice. Much expert research had been done already, however, to establish the probable details of construction, rig, accommodation, etc., of early Seventeenth Century ships; notably on the Mayflower by Dr. J. W. Horrocks at about the time of the Pilgrim Fathers' tercentenary, and by Dr. R. C. Anderson, F.S.A., and Mr. L. A. Pritchard, who designed and constructed, some 30 years ago, the model which is now in the Pilgrim Hall at Plymouth, Massachusetts. Dr. Anderson was explicit, however, in stating that this was not to be regarded as a model of the Mayflower, but (as it is actually labelled) of an "English Merchantman of the Size and Date of the Mayflower."

Piercing all this information together, and doing a considerable amount of co-ordinating research himself, Mr. Baker arrived eventually at the main dimensions to which Mayflower II has been built, namely, 58 ft. length of keel, breadth moulded 25 ft., and 12 ft. 6 in. in depth; the depth is measured, according to the custom of that time, from the level of the maximum breadth to the top of the keel. By the Elizabethan tonnage rule, dating from 1582, which must still have been the accepted rule in 1620, these dimensions correspond to a "burden" of 181 tons—William Bradford's "nine score."

Because of the form of the hull, the projection

Structural timbers are Devon-grown oak; planking and spars are in Oregon pine.

aft of the half deck and poop, and, forward, of the beakhead and bowsprit, it is a little difficult to express the dimensions of the Mayflower II in the terms which are now conventional. "Length on the water-line" or "between perpendiculars" can be given with at least the appearance of precision for a normal steamer or motorship, but it is not easy to locate the corresponding reference points in a ship of the Seventeenth Century; in fact, though the Mayflower II has a fore perpendicular, it can hardly be said that she has an after one, and, because of the sweeping curve of the stem, even the stated length "on the keel" is approximate, though closely so. It may be said, however, that she measures about 77 ft. in length on the water-line, and that her equivalent "length b.p." is about 90 ft.

The building of the vessel was entrusted to J. W. and A. Upham, Limited, of Brixham, Devon, whose yard was established about 120 years ago, and it was under the guidance of Mr. Stuart Upham that we were enabled to inspect her recently. At that time, the three masts had been stepped and the standing rigging set up, but a certain amount of interior carpenters' work had still to be done, and the bowsprit had yet to be shipped, the yards sent aloft, and the running rigging rove. Below decks the structural work was practically completed, but only part of the ceiling was in place, so that it was possible to examine most of the hull construction in detail.

The keel, 12 in. square in cross section, is of oak and is in two lengths, joined by a 2 ft. 6 in. scarf. At the forward end it is connected by a similar scarf to the stem. On the underside of the keel is a "shoe" of oak, 12 in. wide and 2 in. thick, forming in effect a rubbing strip which can be renewed fairly easily if at any time it should suffer damage by the vessel taking the ground. The floor timbers are 10 in. deep and 5 in. "sided" (i.e., in fore and aft thickness), and on them is a keelson, 13½ in. by 9½ in. The frames are of double 5 in.-sided timbers to the upper deck, and single 5½ in.-sided above that deck. Their depth or moulded dimension reduces progressively from 10 in. at the first futtocks (the "twin of the bilge," if the term is permissible in this connection) to a minimum of 3½ in. at the poop deck. On each side of the keel are two garboard strakes, 3½ in. thick by 7½ in. The same section is used within the hull for the limber strakes on each side of the keelson, and for the three foot wales to port and starboard. The main wales, which are worked slightly below the point of maximum breadth, are 9½ in. deep and 5½ in. moulded; and so also the channel wales, which are about a foot below the upper deck at the sides. The planking from the garboard strakes up to the channel wales has a finished thickness of 2¼ in.; above the channel wales, 1¼ in. The ceiling is also 2¼ in. thick. Broadly, all structural timbers are Devon-grown oak, and all planking, as well as spars, of Oregon pine.

The Mayflower II has two complete decks. It is tempting to refer to them as the upper and main decks, the latter being a watertight deck; it would be the gun deck if the vessel carried the guns for which her sides are pierced. In fact, however, the builders call them simply the upper and lower decks, so it will be as well, perhaps, to use that nomenclature. The lower-deck beams are 11¼ in. broad and taper in depth from 12 in. on the centre line to 9 in. at the ship's sides. The actual camber, however, is greater than this, being 12 in. over the 25 ft. of moulded breadth. In this deck is the main hatch, measuring about 6 ft. 10 in. fore and aft by 7 ft. This hatch is closed by the traditional type of wooden covers, and a tarpaulin. The corresponding opening in the upper deck is fitted with a grating to provide ventilation and a certain amount of lighting in the 'tweendeck. In bad weather, of course, this also will be covered with a tarpaulin. The lower-deck waterways (the fore and aft timbers forming the boundaries of the deck at the sides of the ship) are 5½ in. by 7½ in.

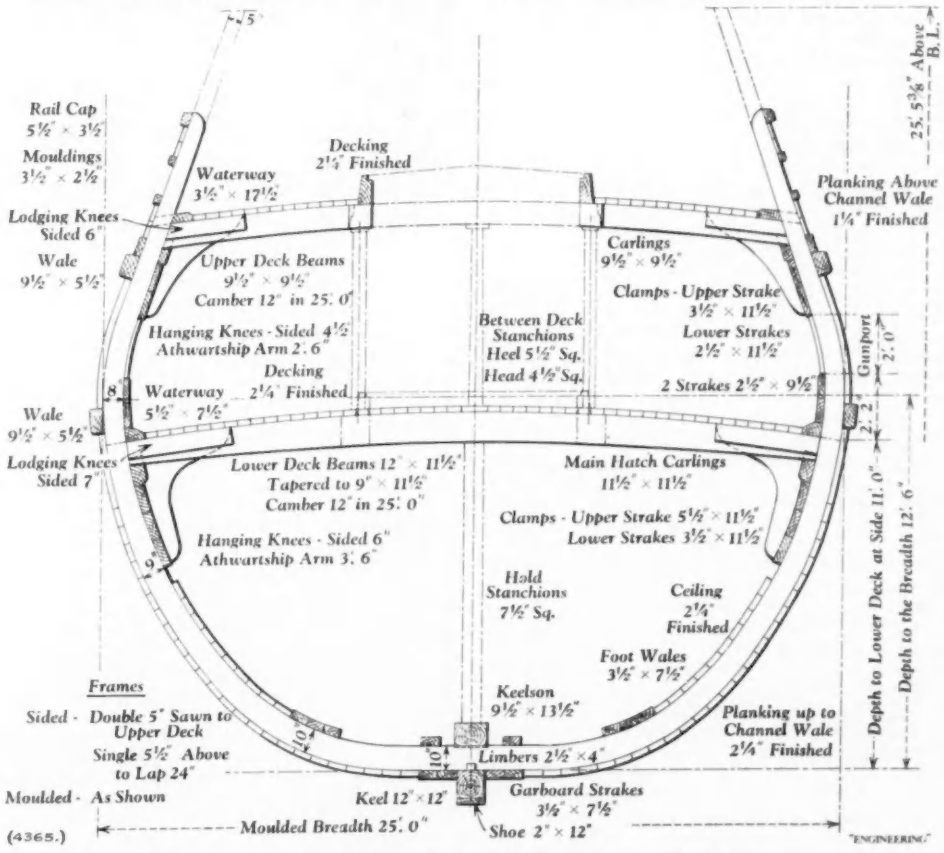
The upper deck beams are 9½ in. square, with the same camber as the lower deck. The main hatch carlings (the timbers forming the sides of the hatch opening) are 11½ in. square, and those of the upper-deck hatch openings are 9½ in. square. The lower deck is supported by a line of hold stanchions, 7½ in. square in section, the heels of which rest on the keelson; and the upper deck is supported from the lower deck by stanchions, 5½ in. square at the heel and 4½ in. square at the head, at the corners of the main hatch. There are also some centre-line stanchions in the 'tweendeck. The planking of both decks is 2¼ in. in finished thickness, as also is the planking of the hull, and the ceiling in the hold. The ceiling is not continuous, the five strakes between the limber strake and the foot wales having been omitted to facilitate stowing the cast-iron ballast between the frames; and the top strake is also omitted, to provide ventilation in the space between the hull planking and the remaining ceiling.

The main sternpost, 11½ in. by 12½ in. in section, extends from the keel up to the main transom beam, which is 11½ in. sided and 15½ in. deep. Abaft it is a false post, to which are attached the five gudgeons supporting the rudder. Both main post and false post are mortised into the keel. The tiller comes inboard through a port in the transom and can be worked by a whipstaff from the steerage in the half-deck; though at sea, in deference to the stipulations of the Ministry of Transport, the ship is being steered, it is understood, by a wheel. The half-deck actually does extend for almost half the length of the upper deck. It is divided between the steerage, where the helmsman stands, which also contains the capstan, and the "great cabin." Above it is a short poop, with a smaller cabin. The capstan has barrels on both the lower deck and the upper deck; thus, not only can more men be accommodated to turn it, but it can be used to weigh anchor as well as for its various upper-deck purposes of swaying up yards and topmasts, hoisting out the boat, etc. There is also a windlass forward, under the forecastle; an interesting "period" reconstruction, though it may be remarked that very similar windlasses are still to be found in the older Dutch fishing craft.

Of the three masts, by far the largest is the mainmast, about 21 in. maximum diameter and 67 ft. 6 in. long. It is stepped on the keelson about 2 ft. aft of mid-length of the ship, and has a rake aft of 4½ in. in 20 ft. The foremast, 17 in. in diameter and 57 ft. 9 in. long, is stepped on the lower part of the stem; it rakes forward 9 in. in 20 ft. The mainmast has seven shrouds a side and the foremast five. Both masts are "woolded" with rope, but this has been done merely for appearance, as the masts are not built, but are both single spars of Oregon pine. The mizenmast is much lighter—10½ in. in diameter and 40 ft. 6 in. long—and is stepped on the upper deck, with three shrouds.

The dimensions of the other spars, as given by Mr. Baker in an article he contributed to *The American Neptune* in 1955 (from which the drawing is reproduced) are: Main topmast, 33 ft. 9 in. by 9 in. diameter; fore topmast, 29 ft. by 7½ in.; main yard, 54 ft. by 13½ in.; main topsail yard, 21 ft. 6 in. by 5⅜ in.; fore yard, 40 ft. 6 in. by 10 in.; fore topsail yard, 16 ft. 3 in. by 4⅛ in.; mizen yard, 40 ft. 6 in. by 7½ in.; spritsail yard, 30 ft. 4½ in. by 6¼ in. The bowsprit is 57 ft. 9 in. long and 13½ in. in diameter, and has a steeve of about 32 deg. It will be observed that several of the spars are of closely similar lengths and sizes, and, in emergency, could be converted to other uses.

The sail plan of the Mayflower II is simple, for there are only six sails: main and fore courses, main and fore topsails, a lateen sail on the mizen and a rectangular spritsail. They have been made from canvas supplied by Francis Webster and Sons, Limited, of Arbroath, who have been engaged in the manufacture of sail-cloth since 1795. The makers of the rigging and cordage, the Gourock Ropework Company, Limited, can claim even longer experience in their special field, having been established in 1736. The Mayflower II is equipped with between 12 and 13 tons of cordage, ranging in size from the 10 in. circumference mainstay and the 7 in. towing hawser to heaving lines and log lines. Reference has been made already in


Rail Cap 5½" × 3½"
Mouldings 3½" × 2½"
Waterway 3½" × 17½"
Decking 2¼" Finished
Lodging Knees Sided 6"
Wale 9½" × 5½"
Upper Deck Beams 9½" × 9½" Camber 12" in 25' 0"
Hanging Knees - Sided 4½" Athwartship Arm 2' 6"
Between Deck Stanchions Heel 5½" Sq. Head 4½" Sq.
Carlings 9½" × 9½"
Clamps - Upper Strake 3½" × 11½"
Lower Strakes 2½" × 11½"
2 Strakes 2½" × 9½"
Gunport 2' 0"
Planking Above Channel Wale 1¼" Finished
25' 5⅜" Above B.L.
Waterway 5½" × 7½"
Lodging Knees Sided 7"
Lower Deck Beams 12" × 11½" Tapered to 9" × 11½" Camber 12" in 25' 0"
Hanging Knees - Sided 6" Athwartship Arm 3' 6"
Main Hatch Carlings 11½" × 11½"
Clamps - Upper Strake 5½" × 11½"
Lower Strakes 3½" × 11½"
Hold Stanchions 7½" Sq.
Ceiling 2¼" Finished
Foot Wales 3½" × 7½"
Keelson 9½" × 13½"
Planking up to Channel Wale 2¼" Finished
Depth to Lower Deck at Side 11' 0"
Depth to the Breadth 12' 6"
Frames
Sided - Double 5" Sawn to Upper Deck
Single 5½" Above to Lap 24"
Moulded - As Shown
Limbers 2½" × 4"
Keel 12" × 12"
Garboard Strakes 3¼" × 7½"
Shoe 2" × 12"
Moulded Breadth 25' 0"
(4365.)
"ENGINEERING"

Midship section through the vessel, which has two complete decks.

For her voyage across the Atlantic the "Mayflower II" carries modern navigational aids, which will be removed when she reaches America.

ENGINEERING to some of the ropes, especially the tacks of the main and fore courses, which are tapered uniformly throughout their length. So far as we are aware, there are no splices in the rigging, seizings being used instead. Also, there are no rigging screws, all the standing rigging being set up with deadeyes and lanyards.

The dictates of common prudence (and, of course, of the Ministry of Transport) require an adequate equipment of dependable navigating instruments, which, in fact, the Mayflower II carries—standard compass, sounding machine, aneroid barometer, sextant, etc. These have been supplied by Kelvin & Hughes, Limited; but the same firm have also provided, with the guidance of the National Maritime Museum at Greenwich, which has an unrivalled collection of early instruments, a compass and binnacle, a cross staff and a traverse board of the kinds that, it may be reasonably assumed, were carried by the original Mayflower in 1620. When the ship reaches the United States, the present-day equipment will be removed together with the other anachronistic gear, such as the radio apparatus, the oil-engined generator to provide current for it, and the tubular-framed bunks for the officers and crew, and every effort will be made to leave her a truly representative vessel of the early Seventeenth Century.

In the design and construction of the vessel, the Mayflower Project has had the assistance, as honorary naval architects, of Sir J. H. Biles and Company, of Westminster, who have some claim to be considered the oldest firm of marine consultants now in practice, for they are now within two or three years of their centenary. To Mr. H. A. Lyndsay, B.Sc., M.I.N.A., the present head of the firm, we also are indebted for much of the information in this article.

★ ★ ★

TRANSISTORS FOR HIGH TEMPERATURES

Silicon transistors that operate at temperatures of up to 160 deg. C. are being produced by the Raytheon Manufacturing Company, Newton, Massachusetts. The transistors are of the PNP type and have a pin-circle diameter of 0·2 in. The company claim that their design is suitable for automatic assembly.

SIR MURDOCH MACDONALD

Controlling the Nile

Perhaps if Sir Murdoch MacDonald had died in April, 1956, instead of on April 24, 1957, the remarkable record of his achievements as a civil engineer would not have seemed quite so striking as it does now. A year ago the name Aswan carried no premonitions of disaster. To those familiar with events in the Nile Valley, the Aswan dam stood as a symbol of triumph in the art and practice of mastering the Nile, and discussions about a new High Dam at Aswan were going forward in an atmosphere of hopefulness. But to-day the High Dam is just one more project for Nile control which, in spite of the time and effort that has been spent on it, remains only in the planning stage: it goes to join other plans such as those for the Jonglei canal, the Lake Tana reservoir, the Merowe dam, the Wadi Rayan reservoir, the Lake Albert reservoir. . . .

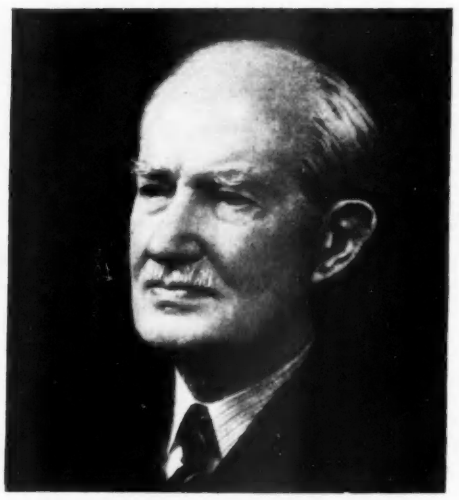
This array of unfulfilled and often mutually conflicting proposals, that have been supported by so great a weight of authority, together serve as a sombre reminder of the complex and formidable difficulties, political, international, economic and technical, that hamper any large-scale endeavour in the Nile basin; but against this shadowy background can be seen all the more vividly the almost heroic figures of the men who did in fact overcome these obstacles and who actually succeeded in raising the dams. Sir Murdoch MacDonald was pre-eminently one of these. Without going so far as some senior Egyptian engineers, who have admitted confidentially to their English friends that they regarded the original builders of the Aswan dam almost as omnipotent supermen, we can still remain astonished at their executive ability.

Nor was it sufficient to build the dam. They had to keep it standing. And it was here that MacDonald's Scottish qualities of courage, confidence and sagacity began to have wider scope. When he arrived at Aswan from Inverness in 1898 his range of authority was limited; but by 1903 he was resident engineer, in control of a structure whose foundations were soon visibly crumbling. The Nile water emerging swiftly from the high-level sluice-ways fell upon the fissured granite of the river bed below, tore out great masses of rock, and then by its back-wash used these as projectiles wherewith to batter the downstream face of the dam. What is so striking now is not only the resolute and resourceful way in which erosion was halted but also the success with which apprehension was meantime kept under control, and tranquillity in Cairo maintained.

When a serious mishap did occur a few years later it was impossible to conceal it from the people of lower Egypt. One night towards the end of 1909, the head regulator of the Menufia canal collapsed and within a few hours it had completely disintegrated. Although MacDonald, now Director-General of Reservoirs, was in no way concerned with the construction of the regulator many years earlier, it was certainly his responsibility to restore the work very promptly, for it controlled the irrigation water for nearly a million acres of land. By the time the next season's flood water arrived in August, everything was again ready for it. A re-designed and improved structure had been completed on a new alignment, new steel gates had been shipped out from Great Britain, and to-day, nearly 50 years later, the Menufia head regulator is still in excellent condition. This success was followed in 1912 by the inauguration of the heightening works at Aswan for which Murdoch MacDonald likewise bore supervisory responsibility. His reputation was now securely established, and was sustained by the warm support of Lord Kitchener, then British Agent in Cairo, and by the award of a knighthood in 1914.

The Great War, which broke out soon afterwards, brought anxieties to Sir Murdoch as it did to so many other officials in Egypt. To these were added trials of a personal and peculiarly vexatious nature. Arising out of the discussion of long-term plans for Nile control, damaging and indeed malicious charges were brought against Egyptian government authorities: they were accused of falsifying the records of Nile flow on which the plans depended. As Under-Secretary of State and Adviser to the Government, Sir Murdoch was directly involved; nor was he cleared until years of technical and legal investigation had proved that the charges were baseless. Nevertheless, this unhappy episode had far-reaching consequences. On the one hand, MacDonald decided that he could no longer live contentedly in Egypt. He resigned his appointment in 1921, set up a consulting practice in London, and for many years thereafter his energy and experience could be devoted to great water-control projects in Great Britain and elsewhere. These included the Great Ouse flood protection acheme and some of the North of Scotland Hydro-electric Board's projects.

The other consequence of Sir Murdoch's controversial years in Cairo was a most fruitful enlargement of scientific knowledge. At the core of those embittered arguments was the problem of the precise measurement of the discharge of the Nile. Yet, standing idle and abandoned at Aswan was the instrument which



might finally help to solve the problem: it was a relic of the efforts of a dozen years earlier to try to arrest downstream erosion. In order to form an experimental water-cushion beneath one of the high-level sluice-ways, masonry walls at the foot of the dam had enclosed a space or pool. Unsuccessful originally, this receptacle was now used as an immense volumetric measuring tank; it could collect during a recorded interval of time the water issuing from one of the sluices, the coefficient of discharge of that sluice could be computed, and after a sufficient number of experiments had been completed and the results correlated in various ways, it became possible to utilise the entire Aswan dam as a measuring device of hitherto unattainable accuracy.

These results were widely acclaimed when they were published in the name of Sir Murdoch and of his scientific associate Dr. H. E. Hurst. But nobody who had not actually witnessed one of the experiments could realise how dramatic they seemed. The hoisting rope of the steam crane was shackled to the sluice gate. At a given signal, the crane would begin to chatter, a jet of water would pour beneath the rising gate into the empty measuring basin, the jet would swiftly swell into a roaring torrent, and the brilliant sun would strike rainbows from the columns of spray that rose high above the parapet. Before the gate was lowered again

after perhaps three minutes, 20,000 tons of water had fallen into the tank. One could not deny the heroic scale of it all—perhaps the supermen were not so far away, after all? Or so at least it may have seemed to onlookers accustomed to exactly similar experiments on a half-inch orifice in a laboratory.

But in another sense that was just the point: was there true similarity? The point was seized upon by Dr. Hurst and his colleagues, who, by experiments on scale models of the Aswan sluices, were among the pioneer investigators to verify the affinity laws between such scale models and very large prototype structures.

Sir Murdoch's interest in Nile control did not fade after he had left Egypt, nor did the Egyptian authorities lose faith in his guidance. They accepted his plan for the second heightening of the Aswan dam, and they likewise entrusted the supervision of the work to Sir Murdoch. Ten years later, Egyptians were able to hear for themselves how he viewed the prospects of yet still further flood-protection and water-storage schemes. At a public lecture at the Anglo-Egyptian Union in Cairo in 1943, he favoured particularly a third heightening of the dam, together with the development of the Wadi Rayan reservoir scheme, 90 miles south of Cairo. Heightening the dam, he said, would be "as easy as falling off a log." If this was the voice of the politician rather than the voice of the consultant, it is true that Sir Murdoch as M.P. for Inverness knew the realities of British politics, while his audience were equally realistic about the connection between the vicissitudes of their own political parties and the fortunes of one or other of the Nile control projects. In such a setting it could hardly be expected that all responsible Egyptians should invariably see eye to eye with Sir Murdoch, but of those who did, none was so staunch an ally as Osman Moharrem Pasha.

Only last autumn, a few months before his death, Sir Murdoch was able to pay tribute to those who had helped him in Egyptian affairs. At an informal gathering at the Institution of Civil Engineers, the President of the Institution had been asked to transmit an American award to Dr. Serge Leliavsky, whose mathematical and analytical powers during many years in Cairo had complemented Sir Murdoch's judgement and experience in the design of Nile control works. Sir Murdoch, then over 90 years of age and himself a President more than twenty years earlier, made a special effort to be present. It was probably his last visit to London.

Si monumentum requiris? Perhaps it would be as well not to go to Aswan just now. It is a long time since the original commemoration stone disappeared—the one with the terse statement, fit to be cut in granite:

THIS DAM WAS DESIGNED AND
BUILT BY BRITISH ENGINEERS

Some of the entries in reference books, relating to Macdonald's Order of the Nile and the Order of Mejidieh and the Order of Osmanieh, go back to the days when Aswan was spelt Assouan. The people who at this moment are profiting from his work are the cultivators in Assuit and Gharbieh and other Egyptian provinces. Because Murdoch Macdonald lived almost continuously on the dam site for ten years; because, over a period of nearly 40 years, he was directly responsible in various ways and at various stages for the structure of the Aswan dam—perhaps more so than any other man; these are some of the reasons why, in May, 1957, the cultivators receive the irrigation water that has been stored for their use in the Aswan reservoir.

HERBERT ADDISON.

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The British Hydromechanics Research Association, South-road, Temple Fields, Harlow, Essex, are holding open days on May 28 and 29. The laboratory there will be available for inspection from 11 a.m. to 5.30 p.m. each day and applications for invitations to attend should be sent to the secretary at the above address.

Weekly Survey

Cover Picture: *The proportion of tankers now included in the merchant fleets of many countries has become very high, and tanker sizes have also tended to increase. Whereas vessels up to* 30,000 *tons were considered large a few years ago, there are now many on order for* 60,000 *tons, and plans have been laid for some of* 100,000 *tons. The illustration shows the stern construction of a tanker built recently for the Peruvian Government.*

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Second Thoughts on Capital Spending

Estimates are now available of the fourth quarter national income figures for 1956. Details of the last quarter of the year show a slight upward trend in both consumer spending and in fixed capital investment. Consumer expenditure is put at £3,606 million or 6 per cent. above the third quarter of the year and not all of this increase appears to have been due to seasonal factors. As would be expected there was a sharp drop in private motoring outlay which is put at 23 per cent. lower than in the same quarter of 1955.

The figures for gross fixed capital formation in the fourth quarter do not make allowance for the recent error in the Board of Trades's estimates. They are given at £839 million which was 2 per cent. higher than in the same period of 1955 compared with an increase of 5 per cent. in the third quarter of the year. If the revised figure for the fourth quarter is used the expansion in the fourth quarter by manufacturing industry goes up to 15 per cent., giving a gross fixed capital expenditure of 5 per cent. for the economy as a whole in 1956.

It is apparent that the trend in the closing months of the year was rather different from the one given by the preliminary official estimates. When Mr. Thorneycroft presented his Budget it was clear that his views on the trend of investment were rather different from those taken by outside informed opinion. His pre-occupation with runaway inflation generated either by heavy consumer spending or a sudden expansion in the demand for capital goods is much more understandable against the background of these latest figures. There are other straws in the wind. The delivery of machine tools according to the latest figures available was still shortening in the early weeks of 1957 but there was also a definite upturn in orders from the home market as well as continuing good business in exports. There has also been a recent improvement in the prospects for the motor vehicle industry. These trends combined with the remarkably small industrial dislocation following the reduction in oil supplies since November are giving the outlook through the summer a much better appearance than was expected in the closing weeks of last year. It remains to be seen what effect the anticipated reduction in building activity will have in the autumn.

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Keeping Exports and Output in Step

Any call for an increase in exports carries with it a special hint for the engineering industry. If this country is to export more it is difficult to see whence the increase is to come except from engineering activity under present conditions. The latest official pronouncements on this subject appear in the current issue of *Bulletin for Industry* put out by the Treasury. It is pointed out that this country needs both increasing exports and increasing output in order to create the necessary surplus in the balance of payments to enable this country to invest abroad again on a significant scale. It is not sufficient, in the official view, to switch goods from the home to the export market because this merely creates inflation at home, or puts an added strain on the import bill. This country needs both an increased volume of exports and a high level of capital investment.

It was Mr. Butler who, as Chancellor of the Exchequer, first underlined the need for an annual surplus in the balance of payments of £300 million. This figure has remained a goal ever since, but it has never been achieved. Even last year the surplus was only £233 million and the five-year average has been under £160 million. It is clear that if exports are to be raised sufficiently to achieve this target and to maintain the high level of capital investment in the home market, the import bill will rise rapidly. The effect on steel imports of the recent recovery in motor vehicle production is a current example of how sensitive the level of imports is to increases in industrial production. To keep capital investment high and the import bill within bounds, it is inevitable that output must expand and that an increasing proportion of the increase must go to the export markets. How to achieve these two ends of economic policy remains the outstanding problem for the next year or two. It would be as well to have achieved some sort of solution before the Free Trade Area begins to present its problems of re-adjustment.

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Beyond the Free Trade Area

Most babies try to run before they can walk and the O.E.E.C.'s latest brain-child is going to be no exception if some of the ambitious nursemaids have their way. Last week, the Secretary General of the United Nations told the Economic Commission for Europe at Geneva that it should consider the probable economic consequences for Europe as a whole of the West European Common Market. In so far as this was a rebuff to the Soviet propagandists who have been trying to suggest that the European Common Market and the Free Trade Area are devices conjured up mainly for the benefit of West German monopolists, it was a useful line of thought. Everything is to be gained in the end by fitting a free trade area into a wider economic concert of Europe.

Such long-term scheming, however, must not be allowed to hide the very considerable task which still has to be completed in establishing both the European Common Market and the Free Trade Area. The Treaty of Rome has established the European Common Market but it still has to be ratified by the six parliaments concerned. The obstacles are formidable. Nevertheless, it is possible to hope that the Treaty will be ratified by early 1958.

The Free Trade Area, which differs from the European Common Market in that its members would have eventually no tariff barriers against each other but individual tariffs to the outside world (whereas the E.C.M. would have a common tariff round the six Messina Powers) is already running behind schedule. The Free Trade Area idea owes much to British initiative and working parties are engaged on thrashing out the headings of a draft treaty. A report is expected in July but may well be late—due in particular to the preoccupation of some of the Messina powers with the European Common Market.

Beyond that lies the problem of fitting in the tariff disarmament proposals between the E.C.M. and F.T.A. systems and the readjustment of Western European industry and trade to all this upheaval. Only when this has been worked out will Western Europe feel inclined to widen still further the area of free trade.

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Sea and Air Transport

At the Annual General Meeting of the Cunard Steamship Company last week the chairman complained of the subsidisation of the two State

air corporations which "have had so far the benefit of capital expenditure of £126 million of public money while their losses to date amount to nearly £40 million." He asked whether it was a wise policy to authorise these corporations to quote uneconomical fares in competition with British ships when in two world wars and more recently over Suez it had been proved how dependent this island was on its Merchant Service. He said that in his view sea and air passenger traffic have been complementary rather than competitive and so far Atlantic air travel has largely promoted its own traffic; total numbers by sea and air have continued to increase. If economic law were allowed to prevail that process would be maintained but the air lines appeared to be able to ignore such normal factors of transportation as costs and profit margins.

This last argument would seem to be somewhat difficult to maintain since the chairman of B.O.A.C. has pointed out that while the Corporation received £31 million by way of subsidy in the immediate post-war years it has made a profit in each of the past six years without Exchequer grant and under the Air Corporations Act has ceased to be entitled to a subsidy. It is nevertheless true that the air corporations are still assisted in respect of capital expenditure and do not at present make a sufficient contribution to the cost of operation of aerodromes to prevent the latter being run at a loss. If, however, the shipping companies have been able to maintain their share of transatlantic business during the years of heavy subsidy they would not appear to have any special cause for complaint at the present time. The air corporations have, of course, aimed at profitable operation through a policy of keeping down fares and thus increasing their total turnover. According to the chairman of B.O.A.C. prices and wage rates during the past 10 years have risen by 60 to 70 per cent. yet the fare to Sydney is 8 per cent. lower than 10 years ago and to New York only 28 per cent. higher. Rising costs have, however, forced a 5 per cent. increase in air fares as from May 1, 1957, though the application of the increase to transatlantic fares was delayed owing to opposition by the United States Civil Aeronautics Board.

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Boom in Civilian Aircraft

The latest announcement by the Society of British Aircraft Constructors confirms that British aircraft continue to be in excellent demand overseas. Exports for the first quarter of this year totalled just under £25 million. The export of aero-engines in particular is growing rapidly. At £8·97 million, they were nearly £2 million more than in the first quarter of last year and it is the highest figure ever achieved. The performances of the Viscounts and the Britannia in the United States, Canada and European countries suggest that Britain has built up a useful lead in turbo-props which should prove highly profitable over the next few years. This is at a time when world airline operators are reported to be at the beginning of a large wave of orders for new aircraft.

There is growing confidence that the steady upward trend in air traffic will be maintained. The major airlines expect that the 1956 figure of 78 million passengers will be doubled by the early 1960s, and that further large gains in traffic will be made in the following decade. Moreover there are signs that financial companies, and particularly the large Institutions, are becoming interested in the long-term prospects of the world air transport industry and are willing to finance the purchase of new aircraft.

The reduction of orders for military aircraft is forcing the industry throughout the world to turn to civil aircraft to take up the slack, and competition will doubtless increase. But Britain is in a relatively strong position, with the Britannias (66 are on order), Viscounts, Vanguards and the Comets. So far orders for the Viscount exceed those for any other aircraft —367 at the end of April—and third in value to the Boeing 707 and the Douglas DC-8, whose orders total over £200 million each. One could over-state the need to make a fast long-distance jet plane such as the DC-8 merely in order to be successful in overseas markets. There is much that remains to be done by some units of the British industry but, equally, much which is being done with commendable speed and energy to make Britain the leading exporter of aircraft and British aircraft the most highly competitive in their class.

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Minerals in Africa

In spite of accelerated development of African mineral resources since the war, the continent remains one whose total resources are still largely unknown. The *Monthly Review* of the Bank of Nova Scotia for March, 1957, in a survey of the mineral resources of Africa, refers to some of the problems to be faced. Two of these, the difficulty of the terrain and the shortage of transport and power facilities, are of long standing, while the acute racial problems facing some parts of the continent have in recent years begun to form a real brake on industrial expansion.

The rise in activity since the war has been due both to rising world consumption of minerals and the currency problems of European countries with African dependencies. Minerals have been extracted in Africa mainly as export commodities both for European consumption and as a source of dollars. While there is a trend towards greater processing of raw materials in Africa, in general industrial growth has been slow, South Africa being the only major industrial concentration, and for a long time to come Africa will continue to rely on exports of primary products. While Africa supplies only a small share of the total imports of the United States and Europe, it ranks high as a supplier of certain minerals. Apart from gold and diamonds, uranium has become of great importance in recent years. In 1955 Africa accounted for one-fifth of the world production of copper, 12 per cent. of that of lead, and 7 per cent. of zinc. Africa supplies over 75 per cent. of the world's requirements for cobalt and 40 per cent. of total platinum production. In addition to these, Africa is an important source of asbestos, tin, manganese and chromium and of rare metals such as columbium, germanium and vanadium.

In spite of this considerable mineral output, the general level of the African economy remains low, though there are wide variations. It has for some time been recognised that investment in basic utilities and social services are as vital to African development as investment in mineral resources. Transport and power remain the major prerequisites to any increase in African production. Most of the transport facilities in Africa have been developed to exploit mineral resources, but in recent years existing facilities have been strained to the limit, notably in the case of exports of chromium and manganese from South Africa, of chromium from Southern Rhodesia and in coal shipments from Southern Rhodesia to the Copper Belt. Similarly, Africa has at present a limited supply of fuels; coal is scarce except in South Africa and Southern Rhodesia and oil production is at present very small. Though African hydro-electric resources are larger than those of any other continent, they are little developed, and mostly lie in the central belt away from the present industrial areas.

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Tonnage Oxygen in Steel Industry

For some years past oxygen has been employed in increasing quantities in the iron and steel industry, and processes involving its use have been helped materially by the reduced cost of the gas resulting from its production on a tonnage scale. Examples of the application of tonnage oxygen, as it is termed in metallurgical circles, some of which are still being perfected, are the enrichment of the blast for the production of pig iron in the blast furnace, the injection of the gas into the steel bath in the open-hearth furnace, and the use of the oxygen "lance" in the electric furnace. The utilisation of oxygen in the blast furnace leads to a decreased proportion of inert nitrogen in the blast, to the possibility of using lower-grade fuels and to other advantages. In the open hearth and electric steelmaking furnaces, injected oxygen speeds up the melting of the scrap charge and, in the final refining stages, assists in reducing the carbon present. The oxygen lance, among other applications, enables large quantities of stainless-steel scrap, previously regarded with disfavour, to be remelted quickly and efficiently in the electric furnace.

In order to bring together iron and steelmaking techniques with the application of tonnage oxygen, a new joint company, Davy British Oxygen Limited, has been formed. The aim of this company is to make available, to the steel industry, "oxy-steel" processes utilising the steel plant manufacturing resources of the Davy and United Engineering Company, Limited, Sheffield, and the manufacturing techniques and tonnage-oxygen plant manufacturing facilities of British Oxygen Engineering, Limited, and British Oxygen Linde, Limited. The capital of the new company will be held equally by Davy and United Engineering Company, Limited, and by the British Oxygen Company, Limited. The directors will be Mr. M. A. Fiennes and Mr. M. F. Dowding, representing the first-named company, and Dr. P. H. Sykes and Mr. F. J. Clark, of the British Oxygen Company. The registered offices will be at Bridgewater House, Cleveland-row, St. James's, London, S.W.1.

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Electrostatic Imagery

A scientific idea may be so remote from its potential application that only a highly efficient standard of communication can effect the necessary union. Such a union is embodied in the principle of Xerography. Photo-conductive materials—materials which conduct electricity only in the presence of light—have long been familiar, but only recently have they been recognised as a means of reproducing visual images quickly and economically. In simple terms Xerography is a process in which the surface to receive the image is electrostatically charged; as a light image falls on the surface, a photoconductive coating allows the charge to leak away from the illuminated areas, so that powdered materials charged in the opposite sense and dusted over the surface adhere to it in the required configuration. Further processing makes the image firm. A description appeared in ENGINEERING on page 654, November 23, 1956.

The process, unlike photography, is dry, and said to be rapid and economic. At a luncheon held by Rank-Xerox Limited to launch the new technique, miniature facsimiles of the day's evening papers and also of ENGINEERING were available at the tables, and as further indication of the speed and versatility of the process, a demonstration run was completed in less than three minutes. Speaking at the luncheon, Mr. Joseph C. Wilson, president of the American Haloid Company and co-chairman of Rank-Xerox, revealed some existing and potential uses of the process. Among its fields of application were the graphic arts and lithography—making new masters from old masters—the copying of documents and engineering drawings, newsprint, the broader use of microfilm and filmsorting, photofinishing, printing from amateurs' negatives—the almost limitless range of powdered materials which can be employed

provides a broad basis for colour reproduction—and in conjunction with X-rays where speed was the main consideration. Though Mr. Wilson considered that Xerography was complementary to photography rather than its competitor, it was possible that it would eventually be used in cameras. It tended to emphasise discontinuities in density and thus was especially suitable for the detection of casting flaws, and its faculty for application to any surface including metals without special chemicals made it a valuable addition to the field of printed electrical circuits. It was, he said, an industry like an iceberg, with only a small part at present above water.

Mr. Wilson quoted a recent study of the fields in which progress was necessary if the underdeveloped countries of the world were to be brought to the level of the more advanced countries. Among these requirements was a major improvement in communications; Xerography was a new form of communication and might therefore contribute to this end.

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Hawkers' Expansion

The vigour exhibited by the Hawker Siddeley Group in diversifying their manufacturing interests has taken the world of industry and finance by surprise. Four major undertakings were announced in quick succession, including the proposal to take over the Brush group, the acquisition of a controlling interest in Algoma Steel of Canada, the formation in partnership with English Steel of a new Canadian company—Canadian Steel Wheel, Limited—and the proposal to form a major new atomic energy development group jointly with John Brown and Company. It may well be that, as Sir Roy Dobson said last week, " the Hawker Siddeley Group expansion and diversification programmes is not yet complete." Nonetheless if all that has been proposed goes through, both expansion and diversification will have been considerable.

The two main characteristics of the deals are the expansion of the group's interests in Canada and the diversification into nuclear engineering. The first signs that Hawkers were aiming high were provided by the offer to Brush. Through them Hawkers would acquire the nucleus of electrical engineering necessary to the expansion of their nuclear engineering interests. The link with John Brown would bring the company into shipbuilding and marine engineering and power station steam raising plant. While the main outcome of such an association might be nuclear-powered ships there is little doubt that reactors suitable for land use would follow. Hawkers' actions, which are in line with those of large companies which preceded them in this field, suggest that more acquisitions or associations might follow.

The expansion into Canada is more than an expression of faith in the continued accelerating pace of development of the country. It is a logical result of the acquisition of Canadian Car and Foundry and the formation of Canadian Steel Foundries Limited. Work will start shortly on the erection of a new plant in Montreal and production of wrought steel railway wheels is scheduled by the end of next year. The acquisition of Brush would give the Hawker group useful knowledge and experience in the building of locomotives. Also, Brush are licencees of Alan Muntz and Company for the manufacture of the Pescara gas generator/gas turbine power unit, which shows every sign of becoming popular for propelling small ships. Hawkers are rapidly joining Vickers and English Electric as a fully diversified large unit typical of the aircraft and guided weapon producer of the future.

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New President of the Mechanicals

The appointment of Sir George Nelson as this year's President of the Institution of Mechanical Engineers is symptomatic of the growing interrelation between mechanical and electrical engineers in modern industry. The formation of joint groups for the development of nuclear power by companies in civil engineering as well as the mechanical and electrical fields is evidence enough that a thorough mixture of experience and knowledge is essential in many projects undertaken to-day.

Sir George was trained as an electrical engineer, having gained a Mitchell exhibition, a Brush studentship and a diploma in electrical engineering of the City and Guilds Engineering College, London, before he was eighteen. He did his works training with the Brush Electrical Engineering Company in Loughborough, and subsequently joined the British Westinghouse Company (now Metropolitan Vickers Electrical Company, Limited) where he stayed for nearly 20 years. In 1930 he was appointed managing director of the English Electric Company and became chairman three years later. In 25 years he took the company to a position of world leadership in the manufacture of electrical machinery, aircraft, rolling stock, instruments, and a wide range of industrial equipment and machinery. Last year Sir George relinquished the managing directorship in favour of his son, Mr. H. G. Nelson. He is now freer to devote himself to the many activities and responsibilities which industry and commerce are pressing him to take.

Education, especially in the technical field, has for long been one of Sir George Nelson's main interests. His long periods of service on the Councils of the Institution of Electrical Engineers and of the Institution of Mechanical Engineers must have helped him to see clearly the educational needs of engineers. His choice of subject for his presidential address to the Union of Educational Institutions, " Technical Education and Human Personality " shows that he sensed —before most of his technical colleagues—the urgent need to broaden the vistas of the engineer, whether mechanical, electrical, civil, or of any other specialised calling. As President of the Mechanicals Sir George will have an opportunity to give a lead on the types of men, and the kinds of education and training British engineering will need during the next decade.

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I.C.E. ANNUAL DINNER

British Engineers Overseas

" If you are feeling young and adventurous, if you want your work to be remembered long after you are dead, do not try to be a statesman or a general—or even a television star. Be a civil engineer, for indeed the great monuments of civil engineering—the Menai suspension bridge, the Panama Canal—are likely to outlive most of the incidents of history," said Lord Radcliffe of Werneth when proposing the toast of the Institution of Civil Engineers at their annual dinner on Thursday, May 2.

He had been reviewing the contribution of the British people to the world; of her soldiers, her politicians and her engineers. Of the British civil engineer, who for more than 100 years had been getting about the world on his benevolent task of bringing to every continent the service of his imagination and skill, Lord Radcliffe: " He will in the future, I believe, represent the most enduring and the least criticised of the British contributions to the rest of the world. In the year 1955-56 there were 55 separate British civil engineering firms working in 62 overseas territories. These firms executed work in that year to the value of £87 million; they obtained new orders to the value of £108 million."

When replying to the toast of " The Guests," Sir Gilbert Rennie, G.C.B., the High Commissioner for the Federation of Rhodesia and Nyasaland, commented on the awards made last year for the Kariba hydro-electric power project. Of the £79 million to be spent on the first stage, contracts had been let to the value of £55 million, and of this sum £40 million (including that which will be spent on local materials) would remain in British hands.

The chair was taken by the President, Sir Arthur Whitaker, K.C.B., who responded to " The Institution." Professor A. J. S. Pippard, F.R.S., vice-President, proposed the toast to the guests who, for the first time, included two ladies, Dame Evelyn Sharp, Permanent Secretary, Ministry of Housing and Local Government, and Miss Mary I. Fergusson, who recently became the first lady to achieve full membership of the Institution.

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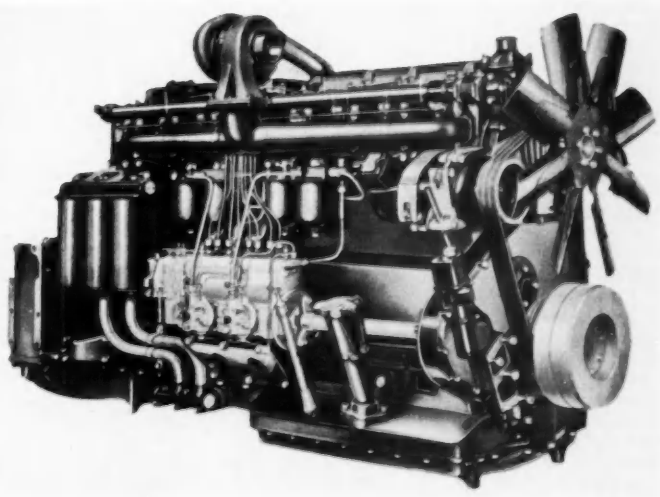
ROLLS-ROYCE TURBO-CHARGED ENGINE

Rolls-Royce Limited have introduced a turbo-charged version of their well-known " C " range oil engines. The eight-cylinder size illustrated develops 350 b.h.p. at 1,800 r.p.m., compared with 267 b.h.p. at 2,100 r.p.m. for the normally-aspirated engine and 333 b.h.p. for the supercharged engine. The six-cylinder size develops 300 b.h.p. at 2,100 r.p.m. (200 b.h.p. normally aspirated, 275 b.h.p. supercharged at the same r.p.m.).

This important development is one of the technical features of an " At Home " which the company are holding at their Sinfin, Derby, works every day this week. An impressive display of equipment in which Rolls-Royce engines are used has been arranged for the benefit of visitors from home and overseas. There are earth-moving machines, air compressors, lorries, transporters, generating plants, a crane, a pumping set, a mobile pit-head winding gear, a twin-engined launch, a Diesel-electric locomotive and two rail-car sets, as well as examples of the " C " range and the " B " range of petrol engines.



The Oil Engine Division of Rolls-Royce will shortly be moving to the Sentinel works at Shrewsbury, where production of the " C " range will be concentrated. The design of these engines is based on the idea of rationalisation, which enables the company to supply a great variety of engines all of which use a maximum number of standard parts.

Letters to the Editor

WATER ECONOMICS

SIR, Your leader on the economic significance of the substantial water resources of Wales (ENGINEERING, April 26, page 513) is most welcome as it helps to sweep away much of the emotional froth which invariably attends any proposed water developments in these islands. Few people will deny your thesis that Britain's future prosperity depends as much on water as on any other vital resource. May I, therefore, underline some of the problems associated with water development.

The water authority, large or small, has an obligation to foresee future water demands, and to arrange that these demands shall be met, but such authorities have no control over the numbers of their consumers, nor have they any powers over the size of their consumers' individual demands. In private industry, the supply and demand of tea and rubber, for example, are kept in balance by the price mechanism—an instrument of control which is denied to the semi-monopolies of the statutory water authorities. Demand and, consequently, the initiation of new developments is controlled solely by the consumers.

The great cities, finding no more water on their own doorsteps, have been increasingly compelled to venture farther and farther afield: Manchester to the Lake District, and Birmingham and Liverpool to Wales. Year by year, as the potential sites for development decrease in number—little scope now exists in the Pennines for large-scale impounding development—competition for the dwindling number of sites that remain becomes continually more severe, and is accentuated by the growing impacts of powerful pressure groups in agriculture, amenity drainage, and the like. Although man's ability to accommodate opposing interests has improved considerably during the present century, this welcome movement towards co-operation is tending to become submerged in the growing flood waters of opposing power blocks. For every good reason why any particular dam should be built, it seems, nowadays, that there are a hundred good reasons why it should not be built. As this country becomes more highly developed, and as each parcel of land becomes dominated by forces opposed to water development, so economic stagnation through inadequate water supplies draws nearer. And the ripples of this stagnation reach the very people who have caused it, for no single part of Britain is exempt.

It might be thought that, as any proposed water development project grew in size, proportionate to the city to be served, so the prospects of its successful promotion would increase. On the contrary, the reverse tends to be the more true. Whilst size hits the headlines, distance transforms the water authority into a foreigner, whether it be a Mancunian undertaking going to Mardale or one from Frisby Dyke going to the Tryweryn Valley. On the other hand, a small local scheme for the local people possesses no parallel conflicts to arouse the emotions; here, there is no David-Goliath projection, such as exists between the small village to be submerged and the all-powerful city.

In the future, English water authorities will look more often than before to the abundant resources of Wales. Many sincere Welshmen, deeply conscious of the relatively high unemployment of the Principality, believe that prosperity could be achieved if the waters of Wales were to be utilised in Wales. The typical new water development project of an English city yields upwards of 50 million gallons a day; an amount equal to the gross demands of a highly industrial township having a population of about half-a-million people. Concentrated in one valley, such quantities of water could not be distributed economically across the mountain barriers of Wales, to assist in the development of industries in the country's widespread unemployment areas. The local utilisation of any such project would require, in effect, the construction in Wales of a Manchester, Sheffield or Liverpool, of not-so-small proportions. What the Principality needs is stimulation to its economy over a great area, not in clumsy indigestible portions. For this overall stimulation, there are abundant untapped local water resources. Moreover, there is no doubt that if any Welsh authority wanted supplies from any of the large English water undertakings, those supplies would be available.

A sound case can be made for a Water Resources Authority of Wales; a statutory body formed to develop and control the country's major water resources. Any development put forward to Parliament by an authority of that standing would have greater prospects of success than exist at present. But this submission poses two questions: namely, who would finance the Authority's schemes, and who would buy the products of its efforts? The long time gap between the development of reservoirs and their full utilisation marks out large-scale water supply as one of the most unprofitable of economic ventures, and places it beyond the reach of all but the wealthy cities.

Surely the answer to the problem lies in co-operation between the Principality and English users, for only through their joint economic efforts can they both derive the benefits they desire.

Yours faithfully,
DELWYN G. DAVIES.

Box 4, Northwich.
May 6, 1957.

S.R. DIESEL-ELECTRIC UNITS

Part of the electrification plan of British Railways includes the extension of the third-rail system on the Southern Region to the Kent Coast, Dover and Folkestone main lines. In view of the fact that this would take some time, the regional authorities decided to introduce some Diesel-electric multiple-unit sets to operate the service until the full electrification was ready. One of the difficulties on this line has always been the narrow tunnels between Tonbridge and Battle, which limit the width of coaches to 8 ft. 0¾ in.

With the introduction of the summer timetable, four Diesel-electric trains will operate in each direction during business hours, and by June, 1958, all steam trains will be replaced by Diesel-electric units which will give an hourly service of fast trains throughout the day.

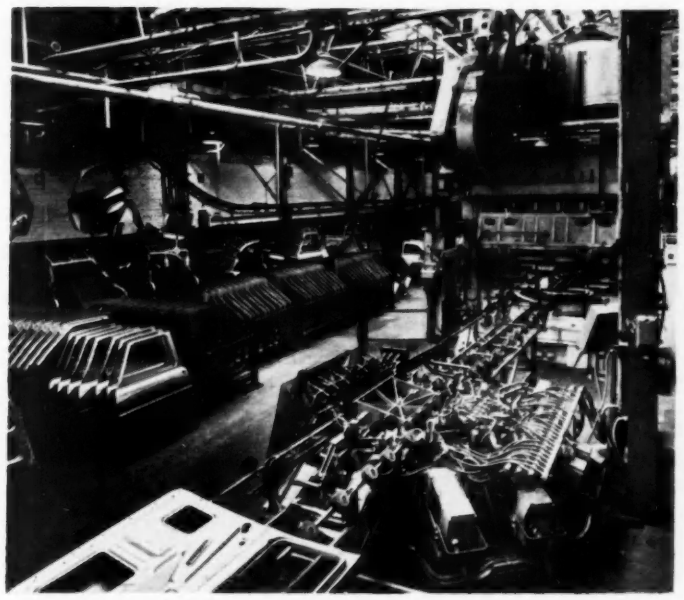
Each train will be made up from six-car units, each unit consisting of two Diesel-electric motor coaches, each with a 500 h.p. Diesel engine, and four corridor trailer coaches semi-permanently coupled together. Two units may be coupled to form a 12-coach train, and all power units will then be under the control of one driver. There will be no passenger corridor connection between the units. The coaches follow the pattern of British Railways standard stock and the first seven units will have 56 ft. 11 in. coaches but the remainder will be 63 ft. 5 in. over the headstocks. Bodies will be of all-welded steel and will, of course, have to conform to the restricted loading gauge.

The driver's controls consist of the master controller and the brake controller. This latter operates the electropneumatic and Westinghouse brakes. The layout is similar to that on the latest Southern Region electric multiple-unit stock and access is through a centre door in the rear partition. However, in this case an emergency door, which can only be opened from the inside, is fitted to the offside of the cab. Behind the driver's cab is the engine room, housing an English Electric 4SRKT/11 pressure-charged four-cylinder Diesel engine, with an output of 500 b.h.p. at 850 r.p.m. This is direct-coupled to an English Electric six-pole generator, with an output of 330 kW, and an overhung six-pole auxiliary generator of 13·2 kW. The main generator supplies 2 four-pole nose-suspended axle-hung traction motors connected in permanent parallel, and carried on the rear bogie of the coach. The motors are identical to and interchangeable with those on the latest Southern Region electric stock. Also supplied from the main generator are the electric heating units in the coaches.

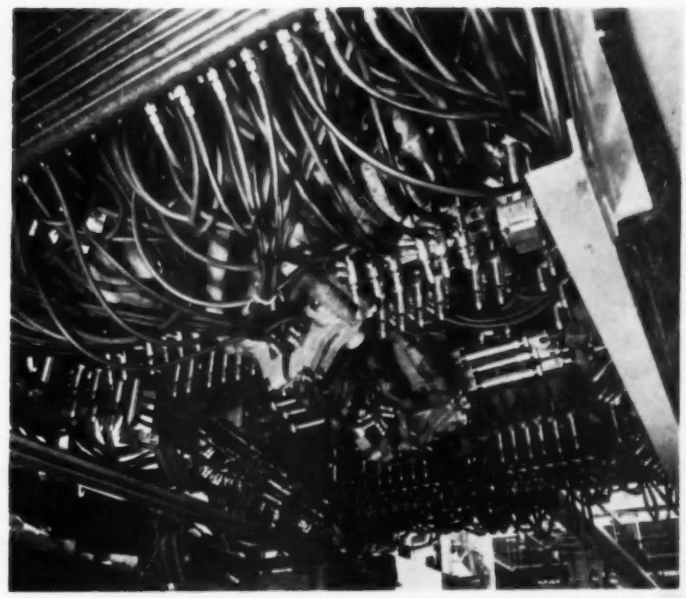
Behind the engine room comes the guard's van, and the remainder of the coach is occupied by passenger seating. Automatic fire extinguishing devices are installed to shut down the Diesel engine if an outbreak of fire occurs, and a discharge of carbon dioxide gas is automatic. The floor of the engine room is welded throughout to form what is virtually a complete oil tray; the level is inclined to one side to allow drainage to take place. The maximum speed for these new units is 75 m.p.h. and the balancing speed on a level tangent track is 68 m.p.h.

To handle the maintenance requirements of these units, the facilities at St. Leonard's West Marina are being increased. A steel and asbestos shed, with as much natural lighting as possible, 440 ft. long and 87 ft. wide, has been built. This has an eaves height of 37 ft. for a length of 100 ft. from the closed end, but elsewhere 16 ft. It encloses four roads with pits, each of which will accommodate a six-car unit, and overhead is a 25 ton travelling crane spanning two of the roads. This is designed to handle the engine generator sets. Owing to the close proximity of the sea, special precautions have been taken against corrosion of the steelwork. Ventilating fans are installed, and a measure of background heating and roof installation included, so that the temperature of the steelwork shall remain above the dewpoint at all times. The equipment is under the control of humidistats and thermostats. A fuelling plant comprising two 23,500 gallon storage tanks and a 1,000 gallon lubricating oil storage tank has been provided close to the shed.

To provide a fast service to the Kent Coast, while the electrification is being carried out, multiple-unit Diesel-electric sets are being introduced.



Multi-head spot welding machines can be mounted directly in an assembly line, as the example shown here which is for motor-car doors.



For large components the " four poster " die-set welding head can be employed; the one shown here is the upper half of a set for welding floor pans.

SPOT WELDING PRESSED STEEL COMPONENTS

MULTI-HEAD MACHINES FOR FLOW LINES

Spot-welding plays a large part in the production of the modern car, which very frequently has a pressed steel body. Until recently, the most popular form was the portable spot-welding gun which is still used extensively in most body-assembly plants, but to an increasing extent multi-spot equipment is being employed. These machines give high outputs, up to 300 assemblies per hour, are economical in their use of manpower and are suitable for use in automatic assembly lines. Eleven such machines, manufactured by Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, have recently been installed at Briggs Motor Bodies, Limited, Dagenham. Here they are being used for the manufacture of the doors, luggage-boot door and floor pans of Ford Grace, Zodiac, Zephyr and Consul cars. Series welding is employed in these machines, and practically no mark is left on the outside surface of the component; this therefore renders the operation suitable for use on those parts for which a quality finish is required, as very little grinding or buffing is needed.

For making the type of weld required for doors, where the majority of the spots are round the edge or the hem, a table-top type of machine is used. The centre portion of the macine is in the form of a roller conveyor which can be raised or lowered. In the raised position the component on the conveyor moves on to the table and is positioned ready for welding. The heads and their associated transformers are located around. Sequencing is automatic, the part moves from the main conveyor to the machine conveyor, is lowered to the welding position, the heads swing in and the welds are made. The heads then retract, the machine conveyor is raised and the welded component is automatically ejected from the machine on to the main conveyor line again. For floor pans and several other assemblies where the components are large, the " four poster " type press welder and die set are used.

The machines are not limited to one design of component, for the equipment such as the welding transformers, the head assemblies, cables and electro-timers can all be used again, merely by re-arranging them in new positions. The welding transformers for this type of equipment have been standardised as far as possible; for example, with only one exception, all the transformers used on the die sets are of 45 kVA capacity, single-phase, rated at 50 per cent. duty cycle. Each transformer has a single primary winding and two water-cooled low-voltage secondary windings. The primary winding is tapped to give a choice of secondary voltage. With the normal series arrangement of the welding heads, each secondary winding supplies two spot welds, so that four welds are made by each transformer. For a large set there may be as many as 30 such transformers, and they can be connected in groups across the three phases of the supply to give, as far as possible, a balanced load.

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STICKING SMALL PARTS IN PLACE FOR GRINDING

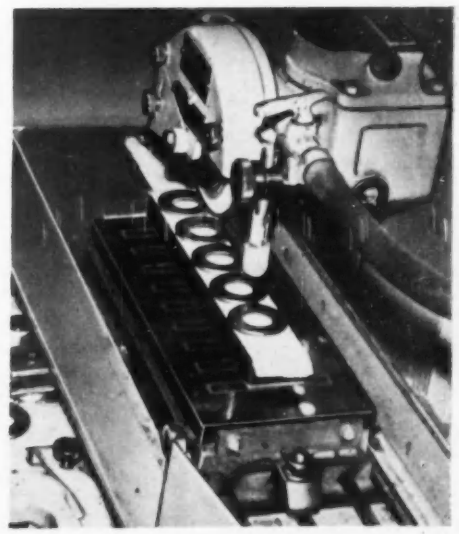
Small flat components can be difficult to hold in place for grinding. If the whole surface is to be ground orthodox clamping is impracticable, and the use of a magnetic chuck may also be out of the question for several reasons. The components may be non-ferrous, or if ferrous they may be too small to be held by the magnetic field, or liable to distortion if held in this way.

To overcome the difficulty of holding such components, Industrial Tapes, Limited, Speedfix House, 142/146 Old-street, London, E.C.1, have introduced a range of double-sided, self-adhesive tapes, with the aid of which the work can literally be stuck in position.

Three grades of tape are available; a light paper tape for perfectly flat surfaces, a medium cloth tape for flat surfaces where great holding power is needed, and a heavy cloth tape which is suitable for rough surfaces, steel plates which curve during hardening, and articles which tend to rock on a magnetic chuck.

It is necessary for both the component and the surface to which it is to be fixed to be entirely free from grease and moisture, and a very simple method of ensuring that this requirement is met is to stick the tape and components on to a steel block or plate, which is then held by any suitable method, a magnetic chuck being ideal. It is not recommended that the tape and components be placed directly on the chuck, as experience has shown that however well it may be degreased, the pitted surface of the lead track is likely to " sweat " grease and coolant. On the other hand, the use of a steel plate of the necessary size enables the grease-free conditions to be obtained easily, and if two plates are kept in use, one can be loaded while machining is in progress on the other. Cooling media can be used in the normal way on the machine, without affecting the adhesion of the tape.

The holding strength of the tape, which is the same in all three grades, depends upon several variables, such as type of material, height of component, and the nature of the work to be done which may be some other type of operation, such as diamond facing, in addition to grinding. A typical operation on phosphor bronze is as follows; adhesion surface 4 sq. in., height of component $\frac{3}{8}$ in., width of grinding wheel $1\frac{1}{2}$ in., maximum cut 0·004 to 0·005 in. Accuracy also depends upon several factors, a typical job ground on both sides is within 0·00025 in. of correct thickness.



Articles which are difficult to hold for grinding can be stuck in position with double-sided adhesive tape.

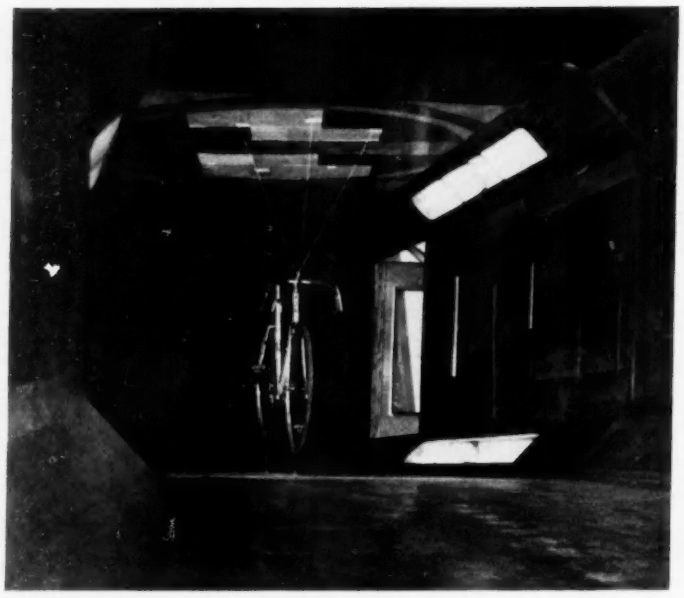


Fig. 1 A racing bicycle was slung clear of the floor in a closed-circuit wind tunnel. It was stabilised by suspended weights below the tunnel floor.

Fig. 2 Cyclist B mounted on bicycle in racing position for measurement of drag, without the cyclist pedalling.

POWER OUTPUT OF RACING CYCLISTS

WIND TUNNEL TESTS AT CRANFIELD

Estimates of the power output of racing cyclists deduced from full-scale drag estimates made in the Cranfield wind tunnel have been made by the College of Aeronautics, Cranfield.* The drag tests were prompted by scantiness of current information on the power available from a human being—information which is of interest to the aeronautical world in connection with the possibilities of human powered flight.

The tests were made on three amateur racing cyclists mounted on their bicycles in a closed-section wind tunnel. The way in which the bicycle was suspended is shown in Fig. 1, two heavy stabiliser weights being slung on the ends of the wires which can be seen passing through the tunnel floor. Each subject mounted the bicycle in turn (Fig. 2) and the fan was switched on to provide airstreams between 40 and 55 ft. per sec. (27·5-37·5 m.p.h.). It was not possible to allow the cyclist to pedal while the drag was being recorded, because of the difficulty there would have been of obtaining steady readings from the drag balance.

The tests were carried out with the subject in "racing" and "touring" positions. In the latter, the cyclist's body is at an angle of some 40-50 deg. instead of being nearly horizontal, as in the racing attitude; and his hands grasp the top part of the handlebars. The results are given in Tables I and II, in which the "drag area" is given for various wind speeds—drag area being the measured drag divided by the dynamic head, that is, half the product of the square of the airspeed and the air density.

In the touring position, all the subjects tested had about the same drag at the same speed, but in the racing position there was some correlation with their size. The approximate constancy of the drag area for each subject demonstrates that the drag varies as the square of the speed. The "drag area" of the bicycle alone was measured as 1 sq. ft.—about 30 per cent. of the total drag.

Subject "B" tried several positions unusual for him, and in one of these, in which he kept his head lower and his elbows closer in than normal, his drag area was found to be 5 per cent. lower; but when subject A tried similar modifications, his drag was increased. The reason is not understood.

TABLE I.—*Resistance in the Touring Position*

Subject	Speed	Drag area
	Ft. per sec.	Sq. ft.
A	35·5	4·03
(5 ft. 7½ in., 144 lb.)	46·6	4·00
B	33·9	4·02
(5 ft. 10½ in., 150 lb.)	41·8	3·96
	44·9	3·90
C	37·2	3·91
(6 ft. 0½ in., 179 lb.)	47·8	3·94

TABLE II.—*Resistance in the Racing Position*

Subject	Speed	Drag area
	Ft. per sec.	Sq. ft.
A	39·2	3·17
	43·9	3·16
	47·4	3·07
	50·2	3·17
	53·3	3·25
	54·1	3·05
B	39·3	3·39
	45·8	3·33
	53·3	3·34
C	38·9	3·50
	48·1	3·48

* *The Air Resistance of Racing Cyclists*, by T. Nonweiler, College of Aeronautics Report No. 106.

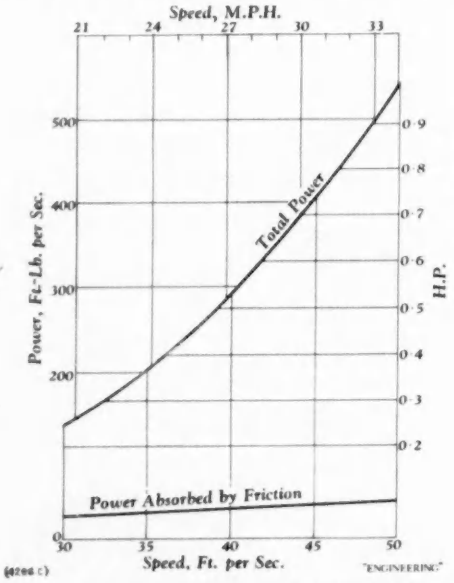


Fig. 3 Power/speed curve, cyclist B maintaining speed in still air and on level surface.

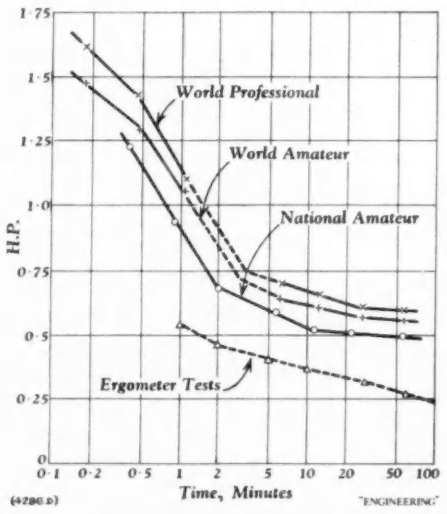


Fig. 4 Estimated power output of cyclists at record speeds on closed circuit.

ESTIMATES DIFFER

On the basis of subject B's performance in road races and the above drag figures, and assuming a coefficient of friction of 0·006 to include rolling and mechanical resistance (based on information supplied by Raleigh Industries, Limited), his speed versus power characteristics were calculated and are presented in Fig. 3; and Fig. 4 gives a "tentative assessment" of the power attainments of record-breaking cyclists on shorter-distance races. The powers thus calculated do not agree with bicycle ergometer tests conducted on trained cyclists at the University of London Department of Physiology, which were not only much lower but also diminished more rapidly with duration. There may be many good reasons for this disparity. For instance, it is suggested, the suitability of the posture of the subject tested on the laboratory machine may affect the results, and so may his incentive to extreme effort. Moreover, there are probably considerable subjective differences in performance.

Institution of Naval Architects Spring Meeting (*continued from page* 557, *May* 3)

TRYING OUT A NEW CARGO SHIP

The fifth paper to be presented at the Spring Meeting in London of the Institution of Naval Architects, at the afternoon session on March 27, was that of Professor G. Aertssen on "Further Sea Trials on the Lubumbashi." For this occasion, the meeting was held jointly with the Institute of Marine Engineers, who were represented by their Chairman of Council, Mr. T. W. Longmuir, on the dais, and by a considerable number of their members in the hall.

The Lubumbashi, a cargo motorship of 9,500 tons deadweight, was exhaustively tested as a new ship by Professor Aertssen, the results being given in a paper to the Institution in 1955. The present paper was a check on the vessel's service performance and condition, as observed before, during and after voyages from Antwerp to New York, and from Antwerp to the Congo. The instrumentation was generally as arranged on the former trials, and full use was made of the Siemens-Ford torsionmeter, the Michell thrustmeter, and the Pitometer log. Particular attention was devoted to the effect of surface roughness of the hull on propulsive performance, and to the measurement of the roughness whenever the vessel was dry-docked. The surface roughness had been measured when the ship was new and again after six months at sea, when considerable corrosion was found. The author's study of the distribution and effect of the increasing roughness occupied a good deal of the paper, which was accompanied by a number of full-size reproductions of photographs of the hull surface.

PLATE DETERIORATION

Mr. G. Dufour, general manager of the Compagnie Maritime Belge, Antwerp, owners of the Lubumbashi, said that Professor Aertssen was more than an efficient scientist; he was also a seaman and, as such, was accepted by the ship's personnel. His influence on them was lasting; long after he had left the ship, the officers and engineers continued to keep as good records as they could, which was an important point to a shipowner. But Professor Aertssen could not be at sea all the time and in all the ships; what he measured was unavoidably a particular case, not an average. If the shipowner could rely on well-kept voyage records, he could get the general pattern.

The measurements over a period of 26 months gave an increase of total resistance by surface deterioration, of 14 per cent. The analysis of voyage results over the same period gave an increase of 12 per cent. In that respect, the Lubumbashi was a disappointment. The hull was sandblasted in dry-dock before delivery and painted with the best available paint; yet, very quickly, there was a surface deterioration as bad as on many older ships where no such care had been taken. She was the first of seven vessels and luckily seemed to be a particular case. The second ship, the Lubilash, was sandblasted when new and painted in good weather with a different paint. After 18 months of service, she showed only 4 per cent. increase in total resistance. The next vessel, the Lufira, was not sandblasted when new, but was painted in bad weather with the same paint as the Lubilash. The increased resistance after 18 months seemed to be about 5 per cent. Of course, those figures were not really accurate. They were based on voyages subsequent to each dry-docking, which meant three voyages for each ship. In time, they might show whether sandblasting was worth while and whether the second paint was indeed better than the first.

Mr. H. J. S. Canham said, with regard to surface roughness, that evidently the pneumatic gauge had considerable advantages for new ships. Numerous readings could be taken in a short time, the accuracy appeared to be acceptable with small roughness, and apparently there was good correlation with sand roughness. Had the author tried different sizes of feeler for estimating roughness? He questioned the remark by the author, in reference to a ship where roughness was measured only between the high and low waterlines, that probably the bottom was rougher than the sides. The British Shipbuilding Research Association, however, had obtained the same roughness for the bottom and sides of a ship after twelve months of service, though the bottom was scaled and the sides were not.

The author had shown separately the effects of surface deterioration and of fouling on total resistance; but was it right to consider surface deterioration and fouling as separate effects? He thought not, and inclined to the view that the value of anti-fouling paint is underestimated. Perhaps cathodic protection would help.

PITCHING EFFECTS ON ROLLING

Mr. D. J. Doust was surprised to see, in the tables of weather data, how small the pitch angles were; which led him to wonder what the roll angles were. It was stated that the pitch angles were measured by a recorder of the pendulum type; what was the reason for that? Would not gyroscopes have been better for a continuous record? It was stated that "There seems to be no appreciable difference between fully loaded and medium loaded condition in so far as the effect of weather on speed and propulsive efficiency is concerned." To what did Professor Aertssen ascribe that?

Dr. J. F. Allan appreciated the author's frankness concerning the limits of accuracy of the various measurements; it was important to bear those limits in mind. The worse the weather, the greater the spread to be expected in the data. Dr. Allan was inclined to agree with Mr. Canham that it was rather difficult to separate fouling from surface deterioration in general.

Turning to the voyage analyses, he noted the increase of power figures of 29 and 37 per cent. for the two Atlantic voyages. Those increases were due to weather conditions only; adding 5 per cent. for general deterioration and fouling gave a total between 35 and 40 per cent., which was not very different from what was allowed for such vessels in general service. There was a tendency in some quarters to consider allowances of that order to be much too big, but the evidence in the paper supported the view, which he shared, that something like 35 per cent. is necessary for services in the North Atlantic. He could understand Mr. Dufour's disappointment over the bad deterioration of the plating of the Lubumbashi, even though it had been sandblasted. The question of protection was very important, and Mr. Canham's point about cathodic protection deserved particular attention. Chemists asserted that no known paint would prevent corrosion taking place under it in time, that salt water would penetrate anything, and that, therefore, there was bound to be deterioration of the surfaces.

Professor L. C. Burrill considered that the owners of the Lubumbashi were fortunate to find a man with the author's knowledge of the subject and care in taking readings who would go to sea for long periods at short notice, and he wondered whether the same kind of thing could not be done in Britain; a young research student might well render very useful service by going to sea, taking such records carefully and presenting an analysis of the results. The effects of weather from different directions were brought out very clearly in the paper and in some ways the figures were frightening. Power increased by some 120 per cent., which indicated really bad weather. The diagram relating delivered horse-power and speed was typical of those he had obtained from the analysis of ship logs, and revealed a good deal of what happened in ships. Evidently, the engineers were trying to maintain the full power of 5,000 d.h.p. all the time, and that object was defeated to only a very small extent. Therefore it seemed that the reason for the differences in performance was the loading of the propeller in bad weather. It would be useful to analyse the wake values in the different types of weather, using open water curves of the propeller. Professor Aertssen had measured the thrust horse-power; what was the relationship between the e.h.p. which a tank would have determined and the e.h.p. derived from the thrust measurements? If the results did not give consistent wakes, it should be possible to learn something about the propeller. Professor Burrill doubted whether the propeller efficiency had fallen as much as 18 per cent., the figure quoted.

Professor E. V. Telfer said that, in his diagrams, Professor Aertssen showed that increase of total resistance from either surface deterioration or fouling, or in combination, was not a linear function with time, but something which increased very rapidly at the start and then slowed down; therefore, any statistical analysis based on the assumption that the function was linear must itself be erroneous. That did not interfere with statistical analysis. It was necessary merely to find a type of time function in harmony with the observed facts, and then to go back to the analysis and, possibly, draw a number of conclusions from other factors than the fouling.

WAVE RECORDINGS

Mr. B. N. Baxter noted that, even when the weather was classified as very rough, the ratio between height and length of the waves was of the order of 1 in 30. The standard $\frac{L}{20}$ wave was not usually met; but the paper showed that, even in the very rough sea condition, the discrepancy had grown until the ratio became $\frac{L}{30}$, which agreed rather well with the formula giving the relationship between height and length of wave as deduced from the Ocean Vulcan trials. He wondered whether it was possible to fit throughout the Lubumbashi, or any other vessel, statistical strain gauges, which would show how many times there had been a stress of (say) 6, 5 and 4 tons per sq. in., and how many times a stress of more than a minimum of 2 tons per sq. in. had been reached. Such figures would be of great interest in relating the bending moment, and hence the stress, with the wave conditions for a particular ship.

Commander Peter Du Cane, O.B.E., R.N., observed that the Beaufort scale for wind velocity was, by its definition, approximate in relation to the actual velocity of the wind at any given time. It was the sea state that mattered, and the method of measuring wave height as observed on the ship's side was not altogether satisfactory; an infinitely small vessel in an infinitely large sea would indicate no height difference on the ship's side. Some such method as that developed by the Institute of Oceanographical Research* might be considered, in which vertical accelerations were measured and integrated twice to give the values of the velocity and the displacement.

Professor Aertssen made a brief reply, which he said he would expand in writing. He maintained, with regard to the remarks of Mr. Canham, that the surface deterioration had nothing to do with the fouling, but agreed that, in relation to the performance of the ship, it was true that the effects of both went together. Pitching had much more effect on the resistance of ships than had rolling; that was why rolling data were not included. He agreed with Professor Burrill that a loss of efficiency of 18 per cent. was high, but pointed out that it was the loss at a given speed, which was reduced in a heavy sea to (say) 14 knots. In calm weather, at that speed, the propulsive efficiency of the ship was very high, of the order of 80 per cent., which was probably one of the reasons why the figure for loss in a heavy sea appeared to be high.

* "A Ship Wave Recorder," by M. J. Tucker, *Trans. I.N.A.*, vol. 98, 1956.

DORMAN LONG COKE-OVEN PLANT MIDDLESBROUGH

DESIGNED FOR SUBSEQUENT DUPLICATION

A new coke-oven plant at South Bank, Middlesbrough, built by Simon-Carves Limited, Cheadle Heath, Stockport, Cheshire, to provide metallurgical coke for the new Clay Lane blast-furnace plant of Dorman Long (Steel), Limited, has now been completed. The builders inform us that it is the largest plant ever built as a single unit in Great Britain; it comprises 150 ovens in two batteries each of 75 ovens, having a weekly through-put of 25,000 tons of coal as charged, together with complete coal and coke-handling equipment and by-products recovery plant. The entire installation, a general view of which is shown above, is arranged so that it can be duplicated at a later date.

Fig. 1 (left) General view of coke ovens showing centrally-situated 5,000 ton coal service bunker, 3 million cub. ft. dry balance gasholder for the clean coke-oven gas, and, on the right of this, the by-products recovery plant.

Coal is discharged by rotary railway-wagon tipplers built by Strachan and Henshaw, Limited, and wagon-thawing bays are provided for use on partly-frozen loads in severe wintry weather. The tipplers discharge through grids into track hoppers feeding a belt to the primary crusher house, where coal over 1 in. in size is screened out and crushed so that from 80 to 90 per cent. will pass through a 1 in. screen. The crushing is done by means of a Flextooth crusher supplied by British Jeffrey-Diamond Limited. The screen and crusher, however, can be by-passed and the coal delivered direct to the stocking-out conveyor, which is 1,000 ft. long between centres. This conveyor can discharge either over its end on to a belt feeding the blending bunkers or, through travelling trippers, to a 100,000 ton stocking ground over which the coal is distributed by bulldozer. The coal is reclaimed, also by bulldozer, into hoppers feeding an underground conveyor to the blending bunkers.

Fifteen blending bunkers, in two rows, fed by two shuttle belts, provide storage capacity for 5,000 tons of coal. After passing through a 50 ton surge bunker, the coal is fed to hammer mills where the size is reduced so that 80 per cent. will pass an $\frac{1}{8}$ in. mesh. The crushed and mixed coal is conveyed to a 5,000 ton service bunker, centrally placed between the two batteries of coke ovens. The contents of the service bunker are discharged into the coke-oven charge cars running along the tops of the batteries, and these, in turn, discharge their contents into the ovens below. All operations are under close control and electrical interlocking mechanisms are used at several points.

COKE-OVEN PLANT

The coke ovens are of the twin-flue compound under-jet type for heating by coke-oven or blast-furnace gas, and, for ease of eventual rebuilding, each battery is sub-divided by intermediate buttresses into five blocks of 15 ovens.

The leading oven dimensions are: length over the sole, 44 ft. 7 in. (cold); height of chamber, 14 ft. $9\frac{1}{8}$ in. (cold); mean chamber width, 1 ft. $5\frac{3}{4}$ in. (cold); taper, $2\frac{3}{8}$ in.; weight per charge, 19·26 tons of coal (wet); and approximate gross coking time, 19·2 hours. The ovens have single ascension pipes on the ram side with liquor-sealed butterfly valves, and the oven doors have self-locking latch bars and are clay luted. The oven-heating system follows the firm's established practice with rich and lean-gas mains in the basement; four reversing winches are provided, two operating 30 ovens each and two 45 ovens each. From a 5 million cub. ft. waterless gasholder at the blast-furnace plant, an 84 in. main brings blast-furnace gas to the oven battery, where it divides into two 60 in. mains passing into the oven basement.

There are two sets of oven machines, all operated by direct current. The firm's electro-magnetic interlock is fitted to the ram and coke guide to prevent the ram from operating until the guide is in the correct position. The coke-quenching cars are designed for a long and trouble free life between overhauls; a special branch line from the coke-car rail track leads to an overhauling bay fitted with an overhead gantry crane. A coke-quenching station is provided at the outer end of each of the two 75 ton batteries. The quenching water drains through grids for the removal of coarse coke breeze and then flows to settling ponds, furnished with telpher grabs for the removal of fine breeze.

From a coke wharf 500 ft. in length, the coke is conveyed at the rate of 180 tons an hour to a primary screening house, from which coke over 2 in., and between 2 and $1\frac{1}{2}$ in., in size goes either to the blast furnaces by belt or to railway wagons by a boom loader. Coke below $1\frac{1}{2}$ in. in size passes to secondary screens and, subsequently, is loaded into road vehicles or railway wagons.

BY-PRODUCTS PLANT

The by-products recovery plant is of orthodox design and embodies the indirect ammonia-recovery system. The foul gas passes to primary condensers, where primary tar and liquor separation takes place, then on to two steam-turbine driven Richardsons, Westgarth/Brown-Boveri exhausters, one of which is a stand by. The gas afterwards passes to five secondary condensers (one of which is a spare) and thence through electro-detarrers to a three-stage naphthalene scrubber tower. The gas then goes to two-stage ammonia scrubber towers. Benzole is recovered by three tower scrubbers in series and the gas is finally freed of naphthalene in three static washers in parallel. Part of the clean gas is returned to heat the ovens, part is directed under pressure into a main to the Warrenby Steelworks, by Holmes-Connersville boosters supplied by W. C. Holmes and Company, Limited, and the remainder goes into the Cleveland Steelworks low-pressure gas main. A 3-million cub. ft. dry gasholder acts as a balance reservoir for the coke-oven gas.

HYDRAULIC TURN-TABLE PLATFORM

An interesting point concerning the execution of this contract is the use of the Simon hydraulic platform for overhead work. This machine, shown in the accompanying illustration, is manufactured in Dudley by Simon Engineering (Midlands) Limited, another company of the Simon Engineering Group, and is specially designed to give rapid access to overhead working positions which can be reached only with difficulty or waste of time by such conventional means as ladders, scaffolding or a bosun's chair. It consists of a lorry-mounted turn-table with two articulated hydraulically-operated booms carrying a working platform, which accommodates two men and their tools and tackle. The rotation of the turn-table and the lateral and vertical movements of the booms can be controlled either from the platform itself or from the turn-table. The particular model used on the South Bank contract gives a maximum working height of 40 ft., and a maximum working radius of 26 ft.

Fig. 2 (right) Simon lorry-mounted turn-table hydraulic working platform for overhead pipe fitting, welding and similar work. This model gives a maximum working height of 40 ft., and a maximum working radius of 26 ft.

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HIGH-TEMPERATURE RESIN LAMINATES

Impregnating Glass Fibre Textiles

Details have recently been announced by Bakelite Limited, 12-18 Grosvenor-gardens, London, S.W.1, of a new phenolic laminating resin which has good mechanical properties at elevated temperatures. It reference number is V17085. It is supplied as a solution in alcohol, particularly for the impregnation of glass fibre textiles which can then be laminated at pressures as low as 10 lb. per sq. in. The storage temperature should not exceed 20 deg. C. At 200 deg. C. the cross breaking strength of a laminate is approximately 26,000 lb. per sq. in.—more than 75 per cent. of its strength at room temperature. This figure can be greatly increased by the admixture of the resin R10993 (proportions 85 : 15) to give a breaking strength of nearly 28,000 lb. per sq. in. at 300 deg. C., providing the exposure period at this temperature is brief.

RAILWAY ELECTRIFICATION IN FRANCE

AN EXTENSIVE FIVE-YEAR PLAN

The French Railway Administration have adopted a five-year plan of modernisation which includes further electrification on both the 25 kV 50 cycle alternating-current and the 1,500 volt direct-current systems. This will, it is believed, lead to economies in fuel consumption, train crews and maintenance staff as well as to fewer locomotive replacements, as an electrified line can be operated with less than half the number of engines that are required with steam traction. The success of the 25 kV system has led to the decision to adopt it for all future electrification schemes, other than those which provide for the further conversion of lines already mainly equipped for the use of 1,500 volt direct-current. The programme provides for a rate of progress 16 per cent. higher than that achieved under the previous plan.

The accompanying map shows the lines that were being operated by electric traction on January 1, 1957, those on which electrification is being carried out during the present year and those which are to be included during the new five-year plan. No distinction is, however, made between the systems to be employed.

Dealing with the scheme in detail, during 1957 the electrification of the lines between Strasbourg and Bâle, Dôle and Vallorbe, and Frasne and Pontarlier will be completed. The Nord-Paris scheme, which includes the Paris-Lille line and various branch lines to Valenciennes and the principal coalfields, will be completed by 1958. The conversion to electric traction on the 300 miles of line covered by this scheme, which will be on the alternating-current system, will save 400,000 tons of coal per annum. The electrification of the lines from Lyon to St. Étienne and Valence on the direct-current system is also due for completion in 1958, and extensions will be made from Valence to Avignon and Avignon to Nîmes in 1959 and 1960 respectively.

When this programme is completed the electrified lines on the French railways will total nearly 5,000 miles, or about 20 per cent. of the whole system. They will carry 70 per cent of the total traffic compared with the present 40 per cent. The annual consumption of electricity will then be 3,500 million kilowatt-hours out of a total national consumption of, it is estimated, some 75,000 million kilowatt-hours.

Existing and planned electrification of French railway lines.

THIRD STAGE OF CONVERSION

Further schemes of electrification, which are to be undertaken during the third stage of the five-year plan, cover over 900 miles of line with an estimated saving of 1,200,000 tons of coal per annum. They comprise the Paris-Châlons-sur-Marne-Sarrebourg line with branches from Epernay to Reims, from Blesme to St. Dizier, from Lérouville and Nancy to Metz and from Toul to Neufchâteau and eventually to Dijon. During 1958 it is proposed to begin work on the lines between Creil and Aulnoye and between Busigny and Somain to provide direct links between Paris and the Belgian frontier and the mines at Aniche and Anzin. The suburban lines of the Eastern Region between Paris and Meaux and of the Northern Region between Paris and Mitry and Orry-la-Ville will also be converted during the same year. The five year plan further provides for the extension of electrification from Tarascon to Marseille.

TWO COLOUR FILMS ON CIVIL ENGINEERING

Two films which have recently had their first showing in London depict the work undertaken on two large civil engineering contracts overseas. Both films are in colour and both make an excellent attempt to portray the background to the project, the design problems that were involved and the site techniques adopted during the work. One of the contracts was undertaken by Richard Costain Limited, the other by Costain—John Brown Limited.

The first of the films, " Pipeline into Persia," describes the construction of a 300 mile oil link between Ahwas and Azna, a vital section of the main line which now carries petrol, kerosine and gas oil from Abadan to Tehran. The film successfully sets out to give an impression of the terrain over which the pipeline had to be constructed, and by shots of models and drawings illustrates how the hydraulic designs were tackled. Later shots show how typical sections of the work were undertaken, such as blasting, trenching, welding of the pipe and backfilling. The film also shows what precautions were taken to preserve the pipe against corrosion.

The second film, entitled " Cutting the Queue," describes the construction of the new Apapa Wharf at Lagos, Nigeria. Hitherto, there has been only one ocean wharf at which ships have been handled, and the great increase in trade passing through Lagos has necessitated the construction of a new wharf, 2,500 ft. long. At the same time, a considerable area of ground has been re-claimed from the lagoon and, again by shots of models and drawings, the film shows how the problems involved have been tackled.

Both films have an attached commentary, and a successful attempt has been made to make the film interesting to the layman as well as instructive to the engineer. Each manages to convey a true atmosphere of the country and of the working site and in neither film has the producer sought to avoid engineering jargon. Copies are available for loan to colleges, and application should be made to the head office of the companies. The address of Richard Costain Limited is 111 Westminster Bridge-road, London, S.E.1; Costain—John Brown Limited are at 73 South Audley-street, London, W.1.

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SERIES CAPACITORS

A large series capacitor installation at Hartley, Southern Rhodesia, is used to increase the stability of the line. The installation is in three sections, one in series with each line conductor. When the line is transmitting normal full-load current, the total output of the sections is 6,000 kVAr. The voltage across each section is 10 kV.

The capacitors were supplied to the Electricity Supply Commission of Southern Rhodesia by British Insulated Callender's Cables, Limited, Bloomsbury-street, London, W.C.1, and were commissioned in August, 1956. Thus the installation is now nearing the end of its first lightning season—a time of severe testing for any electrical installation in the tropics. It is only recently that practical applications have been made of series capacitors.

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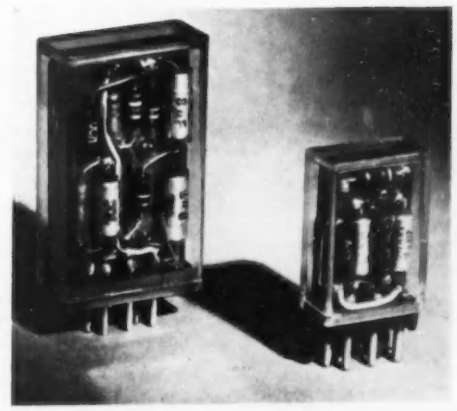
TRANSISTOR AMPLIFIERS

Two types of amplifier, both using transistors, have been developed by Venner Electronics Limited, Kingston-By-Pass, New Malden, Surrey. The first is intended for frequencies in the audio range, and has a response flat within 3 db from 120 cycles per second to 10 kilocycles per second. The second is intended for industrial applications, and has a response within 3 db from 15 cycles per second to 125 kilocycles per second. The voltage gains are between 900 and 1,000 in each case. Both units are built up from two stages, which may be used separately or in cascade. They are enclosed in plastics cases and mounted on eight-pin bases. The smaller weighs three-quarters of an ounce and the larger, one and a half ounces. Both amplifiers are RC coupled, and employ temperature compensation circuits for satisfactory working over the range from − 10 deg. C. to about + 50 deg. C. The designed nominal supply is 10 volts.



Both these transistorised amplifiers give gains of between 900 and 1,000 in two stages. The frequency ranges are from 120 c/s to 10 kc/s and from 15 c/s to 125 kc/s.

PRESSURE JETS FOR HELICOPTERS

DEVELOPMENT WORK AT FAIREY AVIATION

In 1947 the Fairey Aviation Company, Limited, Hayes, Middlesex, started investigations into the possibilities of jet units mounted at the rotor blade tips, to provide the rotor drive by reaction instead of by shaft transmission. Three types of jet were investigated—the ram jet, the pulse jet, and the "pressure jet," in which a primary engine installed in the airframe supplies compressed air to the rotor head where it is fed out through hollow blades to the pressure-jet units at the blade tips into which fuel is injected and burnt. The pressure jets, they found, were by far the most promising possibility; in comparison, the pulse jet and ram jet designed for the same all-up weight had, respectively, cross-sectional areas 5·2 and 9·2 times as great and specific fuel consumptions 2·5 and 3·6 times as high.

The company have therefore concentrated on pressure-jet development, the work being carried out in facilities set up at their White Waltham airfield in 1951, and considerably expanded in 1955. The results have been applied to the design of the Rotodyne 40 seat transport helicopter, the prototype of which is rapidly nearing completion and is expected to fly this year; and to the Ultra-Light helicopter (Fig. 1), which is currently arousing much interest in the United States and, according to the American journal *Aviation Week*, may be constructed there by the Piasecki Helicopter Corporation.

Fig. 1 (left) The Fairey Ultra Light helicopter has tip-jet propulsion.

In general, the basic power plant drives a compressor which, in the case of the Ultra Light, is the (oversize) compressor of the Blackburn-Turboméca Palouste 500, delivering air not only for the pressure jets, but for the turbine as well. In the Jet-Gyrodyne (designed as a flying test bed for the Rotodyne) and the Rotodyne itself, the compressor is driven by the main engine through a clutch. The compressed air is ducted through a regulating valve to the rotor head and then to the blade ducts, which may be formed by the blade spar itself, as in the Ultra Light helicopter and the Jet-Gyrodyne, or by separate air ducts inside the rotor spar, as in the Rotodyne. From the blade duct, the air enters the combustion chamber at the tip of the blade. Fuel is transmitted from a low-pressure fuel pump through a fuel regulator, which meters the fuel flow according to the air mass flow, to the rotor head. From here, the fuel is distributed under low pressure to the fuel lines in the blades. Centrifugal force then takes the fuel to the tips where a fuel column builds up. The centrifugal force of this fuel column provides the high pressure of up to 1,000 lb. per sq. in. for the combustion-chamber fuel sprayers. The mixture is ignited by a high-energy plug and ignition system designed by D. Napier and Son, Limited.

The power of the jet rotor is regulated either by changing the power input into the compressor plant (Ultra Light) or by movements of the air supply valve (Jet-Gyrodyne and Rotodyne). Both types of control are connected to the collective pitch lever with an override control in the form of a twist grip on top of this lever. The fuel supply and air/fuel ratio are automatically adjusted by the fuel regulator. The pressure-jet units work at much richer mixtures than in normal turbojet engines, ranging from stoichiometric at full power to about 30 to 1 air/fuel ratio during cruising.

The Rotodyne works as a pressure-jet helicopter only during starting, landing or hovering. In forward flight the air and fuel supply to the rotor are cut off. The power of the Eland engines is absorbed by normal tractor airscrews providing forward thrust. The weight of the aircraft is partly carried by the auto-rotating rotor and partly by the stub wings. For this flight condition, which covers over 90 per cent. of flying time, low aerodynamic drag of the tip jet units on the rotor is most important. Combustion chambers for this type of rotor must, therefore, be as small as possible and their high combustion temperatures (about 2,000 deg. C.) and combustion intensities, which are very much greater than in normal gas-turbine chambers, are a special design feature of these units.

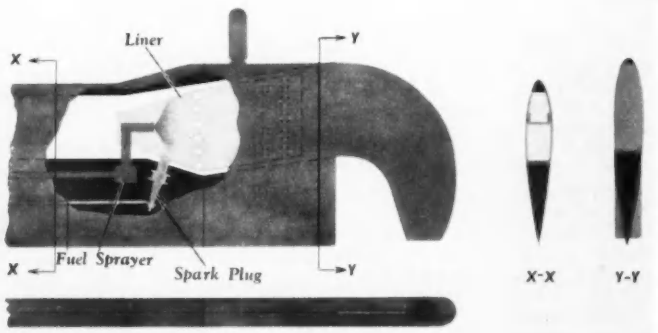


Fig. 2 (right) In the flat combustion chamber, as used in the Ultra Light helicopter, burning takes place radially and the exhaust is turned through 90 deg.

COMBUSTION CHAMBERS

Two types of pressure-jet combustion chambers are used on Fairey jet rotors. The Ultra Light rotor is fitted with flat radial-type combustion chambers (Fig. 2) in which the combustion space is in line with the spar and has a flat cross section so as to fit inside the blade profile section. Burning takes place radially, and only the exhaust of the hot gas is turned round 90 deg. A sprayer forming a flat spray pattern has to be fitted to this type of chamber. One of the advantages can be seen in the clean aerodynamic shape of the blade tip; a disadvantage is that the flat cross-section of this chamber introduces a number of manufacturing difficulties. On the current Ultra Light rotor the net thrust developed by each chamber is approximately 60 lb.; development to nearly double this figure is in train.

The second type is the tangential combustion chamber, circular in cross section (Fig. 3), which is fitted to the Jet-Gyrodyne and which will be fitted to the Rotodyne itself. In this chamber, combustion takes place at right angles to the blade and thus the air flow has to be turned 90 deg. before fuel is injected and burning takes place. This type of chamber is easier to manufacture than the radial type, and is better able to withstand internal pressure and heat. The disadvantages are high pressure drops across the liner and difficulties in obtaining symmetrical flow and burning pattern with the asymmetrical air supply.

The most critical design feature of the combustion chamber is the liner, the holing and shape of which governs the burning efficiency, the pressure drop and the heat distribution along the chamber surface. Correct liner design is always described more as an art than a science and in fact is still based, to a very great extent, on experience.

WATER ANALOGUE TECHNIQUE

To observe the flow pattern inside combustion chambers the water analogue technique is utilised. Water, mixed with some visible particles, is fed through transparent models of the whole chamber or part of the chamber, enabling the flow direction, local densities and turbulence to be studied (Fig. 4). A less elaborate method, used mainly for investigation of detailed problems, is the two-dimensional flow visualisation method, where only cross-sections of the chamber are subjected to a two-dimensional flow of water, the surface of which is sprinkled with Bakelite powder, showing the form of flow, turbulence, and vortices.

After the preliminary design of the chamber, an experimental chamber is made with correct inside dimensions, but fitted with a number of flanges for easy change of liners and for introducing modifications; models for flow visualisation tests are produced at the same time.

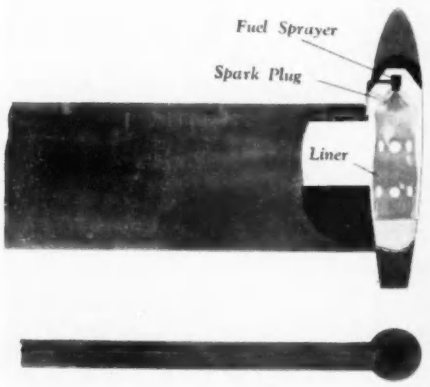


Fig. 3 In the tangential combustion chamber (Jet Gyrodyne and Rotodyne) the air flow is turned through 90 deg. before fuel is injected, and burning takes place.

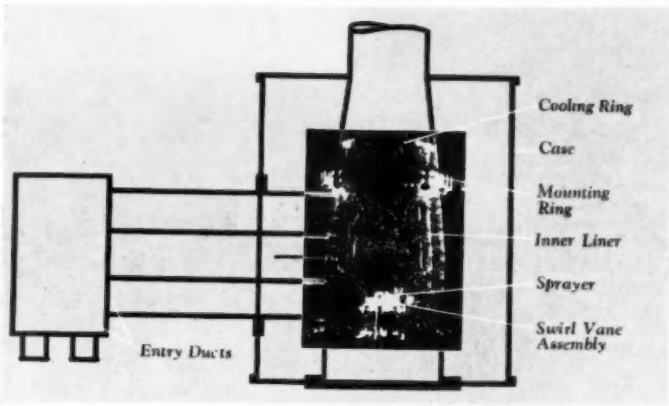


Fig. 4 Three-dimensional water-flow rig.

The experimental combustion chamber is put on a static rig for cold-air testing to investigate pressure drops and flow distribution. Burning tests then follow to determine functioning and performance. Flow visualisation tests on the water rigs are carried out in conjunction with the static tests. After satisfactory completion of the static testing, a further experimental chamber is manufactured for spinning tests on a rotating stand, incorporating the information obtained from the earlier tests. On the spinning rig, the light-up, functioning and performance of the rotating chambers are investigated, with special attention to any change of performance between the static and rotating chamber, due to the influence of centrifugal force. Cooling, heat distribution and stressing of the chambers at correct tip speeds and under the high centrifugal force can only be investigated on the rotating rig.

COMBUSTION TESTS: STATIC AND ROTATING

The layout of the static and rotating rigs at White Waltham is shown in Fig. 5; Figs. 6 and 7 show a more detailed schematic layout for the individual rigs. On the static stand, air is delivered from the compressor plant via an air mass-flow tube with mass-flow measuring instruments, to an air duct representing a length of rotor duct to which the combustion chamber is fitted. There is a flexible connection between the mass-flow tube and the chamber duct, to allow the latter to swing in a horizontal plane. The thrust of the chamber is transmitted through a thrust capsule to a thrust indicator. Fuel is supplied from a high-pressure fuel pump to the burner. Water cooling has to be provided to check the temperature of the exhaust nozzle. Pressure and temperature readings, as well as the thrust indication, are transmitted to instruments in the jet control room.

On the rotating stand, air from the compressor plant passes by way of a mass-flow indicating device, to the stationary and rotating part of the rotor head. From there it enters the rotating air duct which has to be of the same cross section as in the production rotor blade. The fairing of this duct need not necessarily be of correct aerofoil shape and is only fitted to reduce the drag of the rotating duct. (In the Rotodyne tests, however, a close approximation was made to the flight-type blade.) Chamber pressures and temperatures are transmitted electrically via capillary tubes to the centre of the head and from there by slip rings to the instrument panel of the test cell.

After satisfactory completion of static and rotating testing, the complete jet rotor has to be revolved on a spinning rig prior to fitting to the aircraft. Unlike a rotor drive through shafts and gears by a piston engine, the hub and blades of a tip-jet rotor are integral parts of the power plant and are therefore tested as a complete engine unit.

Both the Jet-Gyrodyne and the Ultra Light rotors were tested on the spinning rig at White Waltham. For the four-bladed Rotodyne rotor, a special spinning rig (Fig. 8) has been erected at the Aircraft and Armament Experimental Establishment, Boscombe Down. The power plants, their position in relation to the rotor, the rotor control, fuel, hydraulic and electrical systems are exactly the same as in the aircraft. The rotor running on this rig is therefore fully representative of the aircraft itself.

The two static rigs (Fig. 5) are similar in arrangement. They consist of a compressor house, a mass-flow measuring and ducting compartment, a pump room (including the low and high-pressure fuel pumps as well as the water pumps for cooling the chambers), the control room, and, finally, the combustion-chamber test cell.

On the static stand for Rotodyne research, the compressor plant is a Napier Eland propeller-turbine similar to that which will power the Rotodyne, but without the propeller. The compressor house, with the engine and all its auxiliary equipment such as oil and fuel pumps and oil coolers, is fully sound-proofed; the engine intake is silenced by a splitter arrangement, and the engine exhaust is passed through a de-tuner to complete the silencing.

The air supply from the compressor can be used either for the static rig or for the rotating rig. The control room and combustion-chamber room, also sound-proofed, are connected with each other by an observation window. The chamber test cell is fitted with splitters and another de-tuner for the jet exhaust.

The second static rig is used for research on smaller combustion chambers, for pressure-drop tests, and as a power-plant and control cell

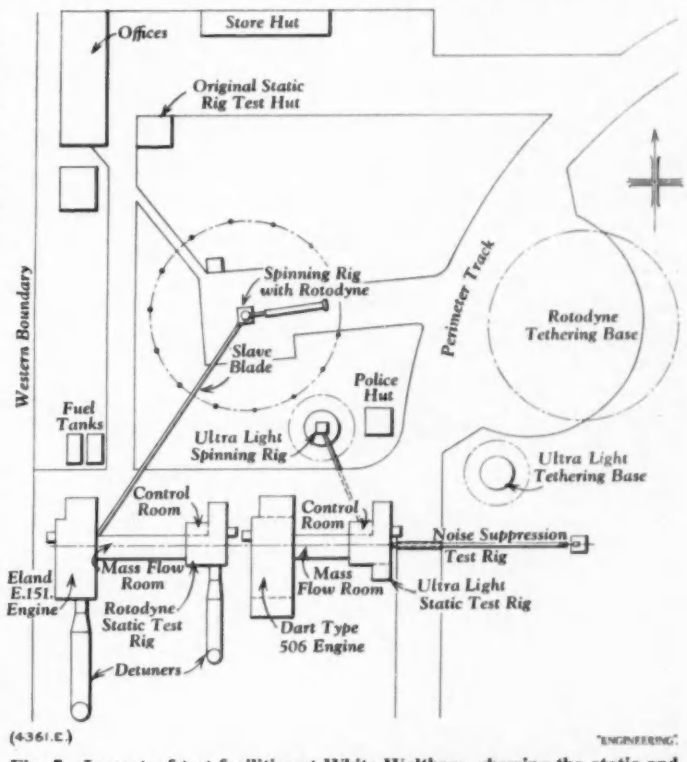


Fig. 5 Layout of test facilities at White Waltham, showing the static and dynamic test rigs.

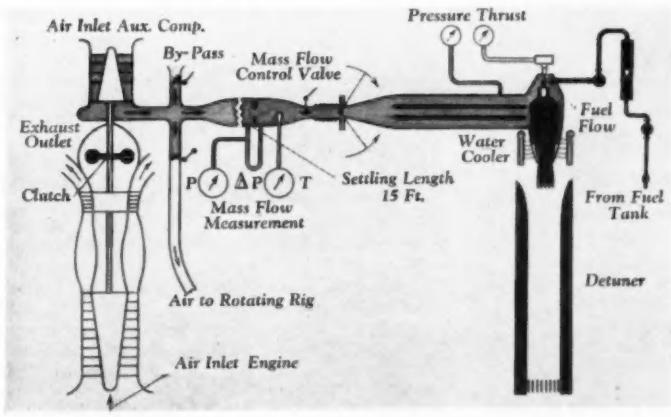


Fig. 6 Static rig for combustion-chamber tests.

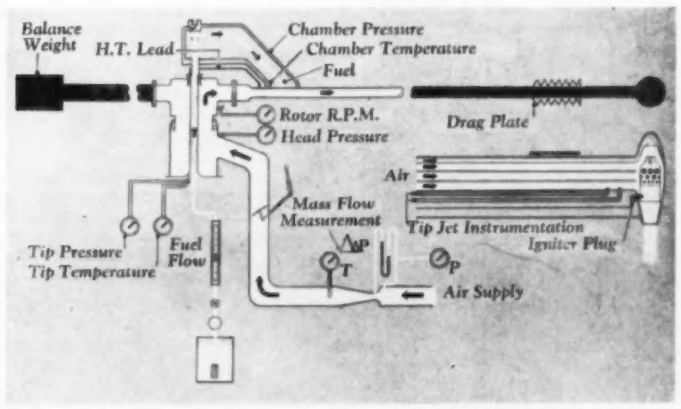


Fig. 7 Rotating stand for combustion-chamber tests.

for the noise-suppression rig. It is also planned to feed an additional spinning rig for Ultra Light development. The compressor is a Rolls-Royce Dart engine, with the power which would normally drive a propeller bled off in the form of surplus air from the compressor. This air can either be used to supply the static rig or, through a longer duct, for noise suppression work on the noise rig. Because of the much smaller size of these units, the compressor and combustion chamber room on this rig are only partly sound-proofed.

The rotating stand for combustion-chamber spinning tests consists of a pivoted pylon which is secured by eight steel cables. Torpedo netting surrounds the stand as a safeguard. A test cabin attached to the pylon contains the air, fuel and ignition controls as well as the necessary instrumentation for investigation of the rotating tip-jet unit. This test cabin is in radio intercommunication with the Eland engine control room from which the air supply is controlled.

Intensive research work at White Waltham has been directed at finding features which reduce, rather than suppress, jet noise, involving the testing of nozzles of a purely experimental nature to determine the effectiveness of various designs. As illustrated in Fig. 9, slotted exits have given the best results, the narrowness of the slots rather than their arrangement being the governing factor in effective attenuation.

Fig. 8 The Rotodyne rotor spinning rig at Boscombe Down.

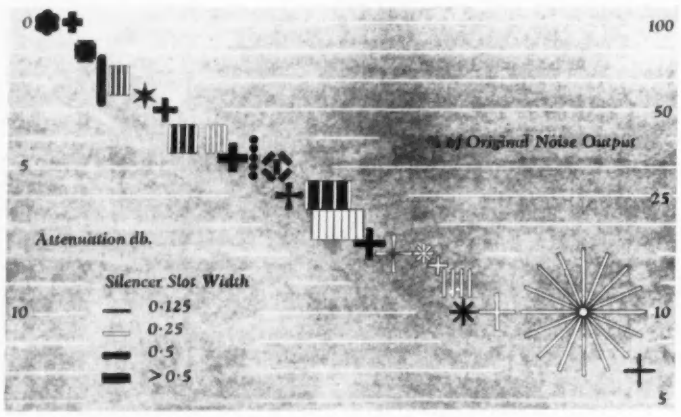


Fig. 9 Experimental noise-suppression nozzles, showing that narrow slotted nozzles are most effective in suppressing noise, and that the disposition of the slots is less important than their width.

Testing commenced at the end of April, 1956, on the present test rig, which consists of the Dart engine in the second static stand, supplying air to a pressure-jet combustion chamber, and a test nozzle situated on a stand 100 ft. out into the airfield from the perimeter track. Air and fuel are metered to the combustion chamber from a control room, under instructions from an observer, who controls ignition at the test stand. The stand carries a panel from which the observer can read the jet thrust and jet pressure. Noise is measured at marker points set every 15 degrees round the test stand at 100 ft. radius. Measurements are made of overall noise and the noise level in each octave band. Overall noise levels are integrated over the surface of a 100 ft. radius sphere to give the acoustic power level of the silencer for comparison with the unsilenced jet.

The work so far has shown what designs to employ for maximum reduction in noise, and the second phase, now well in hand, is to employ this knowledge in the construction of silencers for the rotor pressure jets. The problem is one of arriving at a compromise between maximum possible suppression and the minimum drag and weight.

The testing of full-scale silencers is an essential part of this second phase, and has been done with the unit mounted in the Rotodyne test cell. A comparison between the immediately-achievable noise level of the Rotodyne and the noise level of typical current twin-rotor mechanically-driven helicopters shows that, almost immediately after take-off, the noise level of the Rotodyne falls well below that of the mechanically-driven machine—a result of the high rate of climb of the Rotodyne.

BRITISH AND U.S. FIRMS EXCHANGE ROCKET DATA

An exchange of technical knowledge on liquid fuel rocket engines—primarily those using high-test peroxide—will result from an agreement signed by the Aerojet-General Corporation of the United States and D. Napier and Son, Limited, Acton, London, W.3.

Aerojet-General, with extensive facilities at Azusa and Sacramento, California, are now working on the large rocket engines for the intercontinental ballistic missile, Titan, and are developing and producing the second-stage propulsion system for project Vanguard (earth satellite programme). In addition, the Corporation has long been prominent in the manufacture of jet-assisted take-off rockets (JATO) and in the production of Aerobee and Aerobee-Hi upper altitude sounding rockets. Aerobee-Hi established a new world's record of 163 miles last June and these vehicles will be used extensively during the International Geophysical Year, 1957-58.

Napier has been engaged on rocket research for more than seven years at its Flight Development Establishment, based on Luton Airport, Bedfordshire. The Establishment's equipment includes a multi-testbed installation, and a centrifuge which is capable of imposing alternate positive and negative acceleration loads up to 100 *g* on rocket components and services.

Napier rocket engines have been used in guided missile research at the Woomera Rocket Range, Australia, and, as the Scorpion, in a Canberra jet bomber to test its value as an auxiliary source of power for assisting take-off, increasing rate of climb, increasing level flight speed and for steepening turns at altitude. The Scorpion, which is a "hot" engine, was the first of its type in the world to be tested in flight.

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CLIMBING WINCH FOR BUILDERS' CRADLES

A new range of builders' cradles and slung staging is to be marketed in conjunction with a scaffold winch, the "Skyscraper," which is to be manufactured under licence in this country after a successful introduction in France and on the continent generally. The cradles and staging, available in either steel or light alloys, are being made by Non-Corrosive Metal Products Limited, Horton-road, Yiewsley, Middlesex; the winch is to be made by Tirfor Limited, 27 Broomgrove-road, Sheffield 10.

The Skyscraper scaffold winch, which has a safe load of 10 cwt. with a factor of safety of 12, is attached to the cradle and operated by the man on the cradle who thus has full control over his movements. A steel-wire cable passes through the winch which is designed to give a controlled climb up or down the cable. The cable is reeved round two three-grooved drums, these being turned by a straight gear train driven from the users' handle. Four devices are provided to ensure that the movement is controlled, including the incorporation of an independent brake, thus satisfying the Home Office safety regulations for such equipment used with man-riding cradles. The winch, like the cradles, is available either in steel or light alloy.

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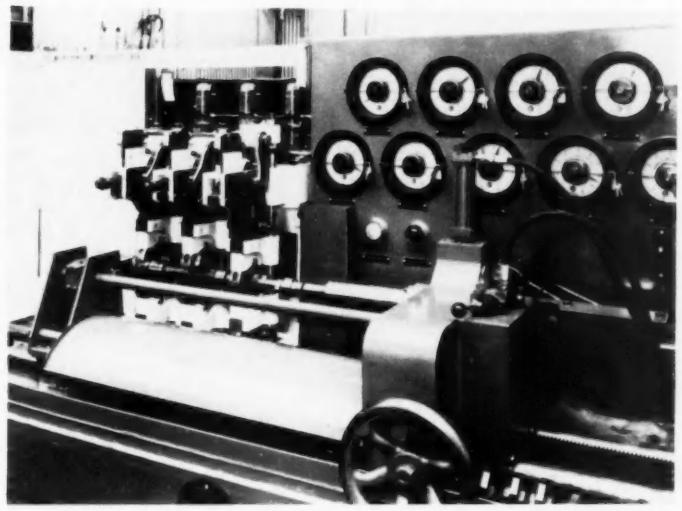
PORTABLE INSTRUMENTS

A new range of portable instruments has been developed by Crompton Parkinson, Limited, Aldwych, London, W.C.2. The range consists of moving-coil ammeters and voltmeters having circular scales and spring-mounted, sapphire jewel bearing, shock-resisting movements. The scales subtend an angle of 240 deg. and are 11 in. long. Two anisotropic magnets are used in the self-shielded type of system. Current ranges extend from 200 microamperes to 150 amperes. Each instrument is housed in a rectangular case of black plastic with metal reinforcing corners. A toughened-glass window is fitted in the circular dial aperture.

INDUCTION HEAT TREATMENT MACHINE FOR CAMSHAFTS

A special camshaft-hardening machine produced by Birlec Limited, Tyburn-road, Erdington, Birmingham 24, has been made for the Australian factory of the Austin Motor Company, Limited. The machine hardens by induction heating, followed by water-quenching, and is designed to treat the wearing surfaces of journals, cams, eccentrics and gears to a depth of 0·05 in., and to through-harden the teeth of the gears. It is capable of dealing with 25 camshafts an hour or 1,000 per working week and is characterised by flexibility and ease of operation as it is intended for use by an unskilled workman who performs the whole process of hardening in one series of operations.

A general view of the machine is shown in the accompanying illustration. In essentials, it is a horizontal three-station single-shot heater, loaded and unloaded manually and furnished with indexing and automatically-controlled heating and quenching mechanisms. Each camshaft, supported horizontally on a work carriage is moved along a track through successive heating operations on the gears, journals and cams respectively. The camshaft is accurately located in each position to ensure correct engagement with the appropriate inductor.



Machine for hardening by electric induction heating, followed by water quenching, the journals, cams, eccentrics and gears on motor-car camshafts. It is intended for the Austin Motor Company's factory in Australia.

The three inductors, arranged at suitable positions along the carriage track, each consist of a pair of movable members held one above and one below the work centre line; they are closed on the work after it has been moved into position. The members are formed with internal water passages that communicate with the inductor bore by means of numerous apertures through which water is directed on to the heated work piece for the purpose of quenching it.

As the cam inductor is shaped to the cam profile, the work is automatically rotated about its axis during indexing to bring each cam, in turn, into alignment with the inductor.

The longitudinal movement and the rotary indexing of the camshaft is regulated by the hand wheel seen on the front of the machine. The carriage is moved against stops that are withdrawn by a trigger operated by pressure on the hand wheel to enable it to be moved to subsequent positions. The appropriate process-timing and inductor mechanisms are automatically selected by the longitudinal position of the work piece. While a camshaft is being treated a sheet-steel hood with large windows is placed in position over the inductor mechanism.

As may be gathered from the illustration, the equipment is contained in a rigid casing of heavy-gauge steel plate, arranged to stand on a level floor and incorporating a rear compartment for electrical equipment and a sump for the collection of the quenching water. The loading position, which extends over half the length of the unit, is placed at a convenient height for a standing operator and above the opening are pilot lights and process-timing indicators.

X-RAY EQUIPMENT FOR OPEN ERECTION SITES

A lightweight radiographic equipment, the Raymax 150, suitable for use in the factory or on open erection sites has been produced by Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester. Two tubes Limited, Trafford Park, Manchester, 17. It is the latest addition to the Newton Victor range. Two tubes are available for use with the equipment. One, the type NVI.400, produces a cone of radiation with a half angle of 15 deg., and is useful for the radiography of welded joints and light-alloy castings. The other, the type NVI.450, has a 360 deg. beam of radiation suitable for the examination of circumferential welds, hollow castings, and small specimens arranged in a circle.

The tube head comprises a high voltage transformer, a filament transformer, and an X-ray tube, all housed in a cylindrical steel tank 18 in. in diameter and 36 in. long. The cylinder is filled with sulphur hexafluoride at a pressure of 20 lb. per sq. in. The breakdown of this gas is similar to that of oil and it has the advantage of being less easily contaminated. The target of the X-ray tube being earthed, water cooling is used instead of oil cooling. Either mains water —if it is of sufficient purity—or a simple closed circuit with a heat exchanger, may be used.

A gantry stand, shown in the illustration, provides a support for the tube head, with a vertical travel of 48 in. Pivots on the long and short tube-head axes permit the beam to be angled in all directions. The control unit is portable but has been designed for wall or desk mounting in permanent installations. The tube voltage is adjustable in the range 50 to 150 kV and is claimed to be sufficient for all light castings, plastic mouldings or assemblies, and welded steel plate up to 1½ in. thick. A synchronous-motor exposure timer is fitted that has a range of 1 second to 55 minutes, in steps of 1 second.

By the extension of the cathode structure inside the hollow anode, the complications of a focusing coil and the need for the adjustment of the focusing current in relation to the tube voltage are avoided. In addition a rod anode tube with a line focus is achieved. The design uses two separate electron beams, at slightly different angles, which can be accurately focused on the target because of the proximity of the cathode. Careful design has minimised the target area and allowed greater tube life.

UNCONVENTIONAL CURRENT TRANSFORMERS

Increased voltages and new switching techniques in power supply systems have led to new problems with the auxiliary equipment associated with them. Current transformers are a case in point. Such devices step down the current in a power supply in order that protective or measuring equipment may be operated by currents of a reasonable size.

The current transformer consists of a few turns—often only one—of a conductor wound round, but insulated from, the main current-carrying conductor. Thus the main conductor itself forms the primary of the transformer. In themselves the current transformers do not disturb the main current, but the small fraction that they tap off is most valuable for the operation of protective equipment. Thus the requirements of a current transformer are adequate insulation from the main supply, and the ability to follow changes in the main supply rapidly.

The advent of air-blast circuit breakers has made the installation of a conventional current transformer difficult. Previously, in large oil-filled switchgear, the terminal bushings afforded a convenient insulated primary—a facility no longer available in the new equipment. Higher voltages too have also increased the cost and bulk of conventional current transformers. Thus it is not surprising that designers should be looking to unconventional types to see whether any should offer an easier solution to to-day's difficulties. However there has been noticeable reluctance to depart from conventional design.

Recent investigations have considered the possibilities of locating the current-measuring device on the conductor and transmitting to a receiver, at earth potential, signals which convey the required information concerning magnitude and phase of current. The Electrical Research Association has considered practical schemes based on these principles. The simplest, described during a recent discussion at the Institution of Electrical Engineers, was that in which sound waves at 50 c.p.s. were transmitted down an insulated tube. The system suffered from the defect that it produced transient effects of its own and also suffered from temperature effects.

A new device that appears to be quite practical was described by Dr. A. J. King. It employs an electro-mechanical transducer at the high-voltage overhead wire, coupled by an insulating rod or tube to a mechanical-electrical transducer on the ground.

The latest addition to the Newton Victor range of industrial X-ray equipment is gantry mounted and is suitable for use on open erection sites.

COMPOSITE CASTINGS OF ALUMINIUM BRONZE AND STEEL

IMPROVED CORROSION RESISTANCE AND STIFFNESS

By C. H. Meigh and G. E. E. Marshall†*

The development of composite castings, made by casting aluminium bronze on a steel core, enables the physical properties of the aluminium bronze to be combined with the relatively-low cost of steel in the manufacture of a wide range of components, and the following article describes a few of the features encountered in this particular production method, which is covered by Patent No. 749249 and Provisional Application No. 33636/56.

The composition of the alloy used to make the castings described below is approximately: aluminium, 10 per cent.; nickel, 5 per cent.; iron, 4·5 per cent.; manganese, 1·3 per cent., and copper the remainder, but any of the compositions commercially known as aluminium bronze can be used to cast round a steel core. Such alloys have a copper base containing from 7 per cent. to 12 per cent. aluminium with additions such as nickel, manganese and iron. These alloys have a number of physical properties not possessed by steel but, in the present article, references are limted to their resistance to corrosion by sea water or chemicals, and to the absence of sparks when objects made in aluminium bronze strike against ferrous metals.

SOLIDIFICATION CHARACTERISTICS

The majority of corrosion-resisting alloys other than aluminium bronze, when cooling from the liquid to the solid state, pass through a temperature-drop of over 50 deg. C. during which they are in a pasty condition and have practically no ductility. During this temperature-drop, contraction occurs which, if impeded, causes cracks and, in normal foundry practice, cores are made of a material which offers little or no resistance to contraction. In composite castings, however, the steel core will not yield under the pressure of contracting metal and it is therefore necessary to employ an alloy which passes from the liquid, to a ductile or plastic state with the smallest possible temperature-drop and correspondingly little contraction.

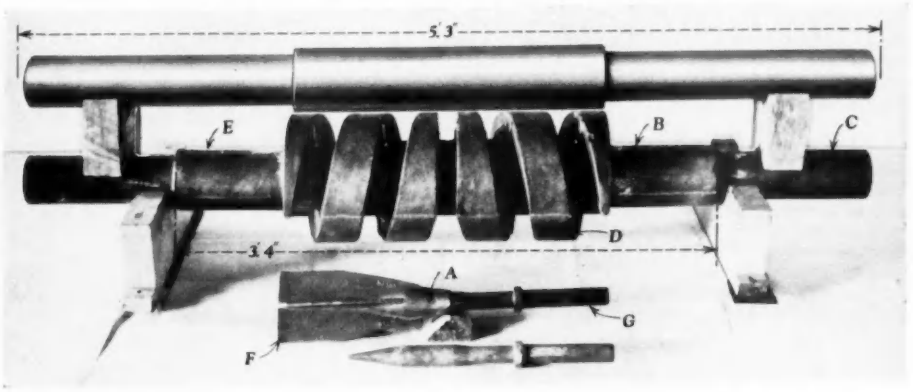
Thus, aluminium bronze, which becomes ductile within a temperature-drop of less than 5 deg. C. from the liquid state, is eminently suitable and enables contraction, which is prevented transversely by the steel core, to be compensated by deformation or permanent set. The reduction in volume or contraction of a cooling body cannot be prevented but it can be controlled directionally, if the material is sufficiently ductile.

The benefits of the composite-casting method of production are greatest in large castings, cast within a mould which determines their external profile but it is in large castings that difficulties may arise due to a build-up of internal stress and consequent warping of the composite casting. Research work has resulted in the discovery of methods whereby stress build-up due to impeded contraction can be controlled and warping prevented.

INFLUENCE OF MASS

It is, for example, necessary to hold within certain limits, the ratio of bronze to steel masses, in any particular part of a composite casting, by regulating the cross-sectional areas of the steel core and of the surrounding bronze. To do this it is preferable to consider the composite casting in its simplest or basic form, i.e., a steel core with a bronze casing. The casing may extend for only a few inches, as A in the illustration above, or several feet, as in B. In this simple form, warping after normalising will not occur if the cross-sectional area of the steel core C is held between 50 per cent. and 75 per cent. of the cross sections of the composite casting, but warping may occur if a smaller proportion of steel is used.

More complex forms such as the screw thread D can be obtained by modifying the mould which determines the external profile of the casting, but the extent to which this may be done without danger of warping depends on the mass of the extension and consequent strength as a contracting body. It also depends on the position of the mass in relation to the core. Take as an example, an imaginary mass out of which the screw thread D could be machined, as compared with the much smaller mass of the cast threads. The former would be liable to cause warping after normalisation and during machining, the latter would not. Nor would warping occur if the cylinder in question were situated at the end of a casting where there is no core. The foregoing examples are obvious but in practical applications, borderline cases occur in which the results can only be determined by experiment.



Aluminium-bronze components cast on a steel shaft. (By courtesy of Meigh Castings, Ltd.)

PRODUCTION COSTS

It will be understood that the embodiment of complex forms in the mould increases the proportion of aluminium bronze in the composite casting but, nevertheless, the production method either provides a casting with valuable properties not possessed by steel or reduces the cost of the finished article by eliminating machining and fitting operations which would, otherwise, be entailed if the components B, D and E were manufactured separately and subsequently assembled.

The steel core itself, may be profiled, as shown uppermost in the illustration, either with the object of replacing a greater proportion of the more costly material or so that stresses in the composite casting may be kept within desired limits and the best possible use made of the particular characteristics of each metal. An example of careful distribution of bronze and steel will be described later when referring to the service requirements of the pneumatic digger G.

STRESS FORMATION

When considering the behaviour of a composite casting during and after production, it should be noted that the coefficients of thermal expansion of steel and aluminium bronze are approximately $0{\cdot}119$ and $0{\cdot}170 \times 10^{-4}$, respectively, and that the melting point of aluminium bronze is about 1,080 deg. C.

While the bronze (E, D, B) is being cast round the steel core (C) it exchanges heat with the steel and solidifies. The steel expands during the casting operation and also for a certain period after the bronze has solidified; while the bronze starts to contract as soon as it becomes solid. At one period, therefore, the bronze is contracting while the steel is expanding and this results in the permanent deformation of part of the bronze. In the subsequent period both metals contract at the same time but the contraction of the bronze is greater than that of the steel and when prevented transversely it is compensated by deformation or permanent set.

Deformation which occurs above 750 deg. C. has no strain-hardening effect on the metal, but while cooling through lower temperatures the metal strain hardens, and internal stresses are created in a manner similar but, to an extent greater than when a sleeve is shrunk on to a shaft.

TENSILE STRENGTH AND DUCTILITY

In shrinking, or in casting an object on to a shaft, the pressure between the object and the shaft, or the resistance of the object to slip on the shaft, depends on the amount of metal in the object and on the degree to which it is stressed, while the margin of safety against fracture depends on the ductility of the metal. To enable values to be put on these factors, test pieces were cut from a casting after normalisation and the following results were obtained:

Screw (D):—0·1 per cent. proof stress = 13 tons per sq. in.; ultimate tensile stress = 36 tons per sq. in.; elongation on a 2 in. gauge length = 20 per cent.

Sleeves (B) and (E):—0·1 per cent. proof stress = 17 tons per sq. in.; ultimate tensile stress = 43 tons per sq. in.; elongation on 2 in. = 29 per cent.

These figures apply to the alloy composition to which reference has been previously made, but modifications to the characteristics of the alloy used can be made, to suit particular requirements, by relatively small changes in the composition. These have the effect of increasing the tensile strength to the detriment of elongation or vice versa.

Composite castings such as pump screws retain during their subsequent service life, characteristics obtained by normalisation, but, in other applications, the characteristics are affected by work hardening which occurs under service conditions, and a description is now given of the work done by composite pneumatic tools, such as the digger G.

COMPOSITE PNEUMATIC DIGGERS

Tools of this description are used by the gas industry* for breaking up iron-oxide, which becomes a very hard amalgam in the gas-purifying plant, after extracting sulphur from the gas.

* Of Meigh Castings, Ltd., Cheltenham.
† Of Stothert & Pitt, Ltd., Bath.

* "Non-Sparking Tools." *Gas Journal*, vol. 276, page 730. December 16, 1953.

These tools have standard shanks fitting loosely into a socket which receives repeated shocks from a pneumatic hammer working at a pressure of 100 lb. per sq. in. Steel tools cannot be used with safety on account of the danger of igniting pockets of gas by sparks from the steel, when the tool strikes ferrous objects in the purifier box.

Aluminium bronze alone, gives relatively short service because although the design of the blade F can be made to take the required bending loads under repeated shock, the shank fitting G has to remain standard size, and fracture occurs at or near the collar. The only alternative is to use steel shanks, made in the same material as the standard all-steel tool, and cast on a bronze sleeve A which carries the required shape of digger blade F. The illustration shows the steel shank (G) and the composite casting, and it will be noticed that the cross-sectional areas of the core and the casting are regulated so as to eliminate stress concentrations during service as far as possible.

Composite tools designed on these lines are put into service in the normalised state and the bronze work-hardens at a speed which is governed by working conditions. In the normalised state the bronze acts as a " shock absorber " for the steel shank but, after a period of work, during which the 0·1 per cent. proof stress of the bronze is increased to 25 tons per sq. in. and the elongation is reduced to 16 per cent., shock is no longer absorbed by the bronze and if the hardening process is not curbed it extends to the steel shank and rupture occurs at, or near, the collar. Periodical normalisation at 750 deg. C. re-establishes conditions which do not fatigue the steel, and a tool will give well over 500 hours' service.

The points of interest in this application are: that in no case has a cast-on sleeve (A) burst on account of shrinkage stresses and work-hardening and, in no case has a sleeve worked loose, even after frequent normalising operations in which both the steel shank and the cast-on bronze are heated together. It is, in fact, necessary to heat the bronze almost to melting point even before it can be removed from the steel shank for recuperation purposes.

In this particular application of composite casting, the steel is used only to reinforce a non-sparking tool and not because it reduces the amount of the more costly bronze or, inversely, the bronze is used to protect the steel from impact. In another application described and illustrated below, the composite casting production is used for economical as well as technical considerations.

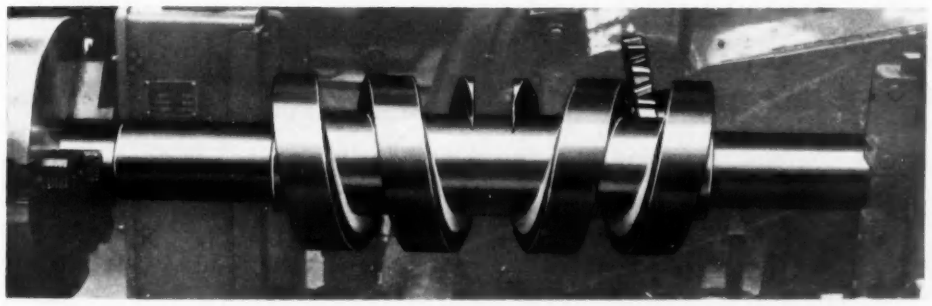
COMPOSITE CASTINGS IN PUMP MANUFACTURE

It is essential to the efficient working of any type of positive-displacement rotary pump that the fine clearances to which they have been manufactured are maintained when in operation against pressure. The free selection of materials to give a robust and rigid construction is not always possible because they have also to be chosen to resist any chemical action of the fluid being handled. For example, pumps which handle salt water have to be made of suitable materials to resist the severe corrosive action which can be set up, and this can best be done by making them wholly of non-ferrous materials, preferably aluminium bronze, which while having a very high resistance to corrosion can also eliminate any electrolytic action due to the absence of dissimilar materials.

While non-ferrous materials offer the best solution to the prevention of corrosion, they have a comparatively low modulus of elasticity when compared to steels. Pumps constructed from such materials might be quite suitable for normal discharge pressures, but where the pressure is high, a closer study is necessary to satisfy the requirements of rigidity.

In the case of screw displacement type pumps, the illustration on page 594 and that reproduced below show what is being done to increase the stiffness of the screws forming the pumping element of a salt-water pump. The aluminium-bronze screw is cast on a steel shaft with the bronze extending from the screw through the stuffing box to the outside of the pump body making a composite member which, while having the corrosive resistance of bronze, has a considerably greater resistance to deflection. As explained earlier one important advantage of composite castings is the replacement of a comparatively costly material by steel and the increase in diameter of the steel is a typical example.

It might be argued that a similar saving in bronze could be made if the screws were fitted separately but this would entail careful and costly machining as an additional operation. A pair of composite screws as fitted in a pump, and shown in the above illustration, weigh 884 lb., of which 475 lb., or about 53·7 per cent., consist of steel. As a result the casting is stiffened and cheapened by the steel, and the steel is totally protected by the bronze, each metal being used to its greatest possible advantage.



Partly-machined pump screw, 9¼ in. in diameter, cast on a steel shaft. (By courtesy of Stothert & Pitt, Ltd.)

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CUTTING SCRAP

Shears for Yard or Shop

George Cohen Sons and Company, Limited, Sunbeam-road, London, N.W.10, have been appointed sole world agents for the " Eldair " range of alligator shears made by Weldall and Assembly, Limited, Stourbridge, Worcestershire, and the range now comprises five models, all of fabricated steel construction.

Four of the machines in the range are of the type shown in Fig. 1. They are fully portable, being fitted with wheels and a swivel axle and tow bar. The drive is through machine-cut gearing from an electric motor, a petrol engine or a Diesel engine, according to choice, and the working parts are enclosed and weatherproofed for outdoor use. Shear pins in the flywheel prevent overload. Bronze bushes are fitted to all bearings, and lubrication is by grouped grease nipples. A safety bar is fitted to protect the operator from the possibility of the piece being cut kicking up. This bar can be swung up at right angles to its working position when it is not required. The blades have four cutting edges, and there are adjustable knife blocks for easy blade setting. Extensions of the top arm and the frame act as crushing jaws for flattening such articles as drums before cutting.

The lightest of the four machines runs at 60 strokes per minute, has a blade length of 12 in., and will cut 1½ in. diameter mild-steel rounds or their equivalent. A very similar machine, with the same cutting capacity, but running at 40 strokes per minute, has 30½ in. blades, to enable standard corrugated sheets to be cut in one " bite ". For heavier work there is a machine with 30½ in. blades which runs at 40 strokes per minute and will cut 1½ in. rounds. The heaviest machine in the range also runs at 40 strokes per minute, but has 24 in. blades and will cut 2 in. diameter rounds.

The smallest of the five models is shown in Fig. 2. Its construction is obvious from the illustration, but it should be added that it can be fitted with wheels if desired. It has blades 8 in. long, runs at 40 strokes per minute, and will cut ¾ in. diameter rounds or their equivalent. A petrol engine drive is available as an alternative to the electric motor drive shown.

Fig. 1 (above) Long blades on this " Eldair " shear enable corrugated sheets to be cut at one bite. Other models have shorter blades and will cut heavier material.

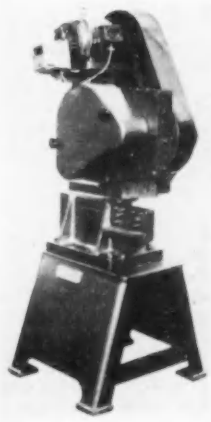

Fig. 2 (right) The smallest machine in the range can have wheels or feet, as required. As with the other models, alternative methods of driving are available.

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PLASTICS FILLER

Putty or Cream Grades

An all-purpose plastics material for filling, moulding and jointing is now being marketed by the Kenilworth Manufacturing Company, Limited, Hermetite Works, West Drayton, Middlesex. Known as Hermetal " Double Bond " it is made from epoxide-based resins and is available in two consistencies—" putty " or " cream." The former is for moulding by hand and the latter can be spread with a knife or spatula to fill irregularities. Both forms are supplied as two components and curing takes place only after mixing. Pot life of the mixed compound is from 3 to 4 hours at 60 deg. F. Curing is complete in 24 hours at room temperature, or in less than 10 minutes at 180 deg. F. Infra-red heating can be used. The filler is resistent to most acids, alkalis and organic solvents.

Book Reviews

GOOD CONCERT HALL DESIGN

Raum- und Bauakustik für Architekten. By WILLI FURRER. *Verlag Birkhäuser, Basel, Switzerland.* (27.50 Swiss francs.)

The proof of a pudding is usually said to be in the eating, but in the field of architectural acoustics the diners' opinions have too often been overlooked. This is particularly true of the last two or three decades since it has become possible to concoct the recipes by scientific or apparently scientific means.

Life was comparatively uncomplicated for the builders of the Nineteenth Century concert halls which appeared after the industrial revolution. Any good hearing qualities must have been largely accidental, or, more probably, a result of copying the common features of the more successful existing designs. Thus, several of the most famous of the halls which survived until recent years bore a striking resemblance to the old Leipzig *Gewandhaus* which itself had a fine reputation. The Basel Casino hall, which is one of the surviving examples of this type, is illustrated on the opposite page. It was characterised by a rectangular shape, wide side and rear balconies, and copious ornamentation which undoubtedly had the effect of scattering the sound during reflection, and preventing the formation of strong standing-wave effects.

Although the foundations of the scientific study of acoustics were laid over sixty years ago by Sabine, it was not until the inter-war period that intensive work began and, for the first time, detailed consideration was given to the shapes of concert halls. The tendency was to regard the hall as a transmission element which should be designed to convey sound from the performer to the hearer with the minimum attenuation and change. The reverberant sound caused by reflections from the wall and ceiling surfaces was at worst an inadmissible distortion, at best, a means of maintaining a satisfactory loudness.

This concept produced commendable results in the design of cinemas, where the acoustic atmosphere built into the sound track should be conveyed faithfully to the hearer, but in the case of concert halls the results were aesthetically unsatisfactory. The Salle Pleyel built in 1930 is shaped like a parabolic reflector with the stage as the focus. It quickly gained a reputation for clearness of speech, but is so unsuccessful as a concert hall that it is now seldom used for the purpose. Nevertheless, these basic ideas persisted. It was difficult to obtain a clear concensus of opinion on the musical qualities of a hall, if only because few people had the opportunity of comparing numbers of concert halls under concert conditions. Research forged ahead, producing notable progress in all its physical aspects, but few subjective investigations were carried out. In fact, the tendency was, as it were, for the diners to be told that any new flavours to which they objected would soon become acquired. A few concert halls were built, but none bore comparison with the best of the traditional halls.

In the last ten years, however, there has been a revival of interest in concert hall acoustics. New halls have been built or planned, in many instances to replace those destroyed by the war, and there have been several serious attempts, taking advantage of improved recording methods, to find out what the critical concert-goer really desires. Though there is no universally agreed answer to this question, the post-war halls tend to revert to earlier forms of design, and adequate reverberation is now universally accepted as necessary for the production of good tonal quality. It seems that, one by one, the principles which inspired the Salle Pleyel are being discarded; the large smooth reflecting surfaces are going and designs are moving in the direction of well broken-up surfaces and rectangular plans.

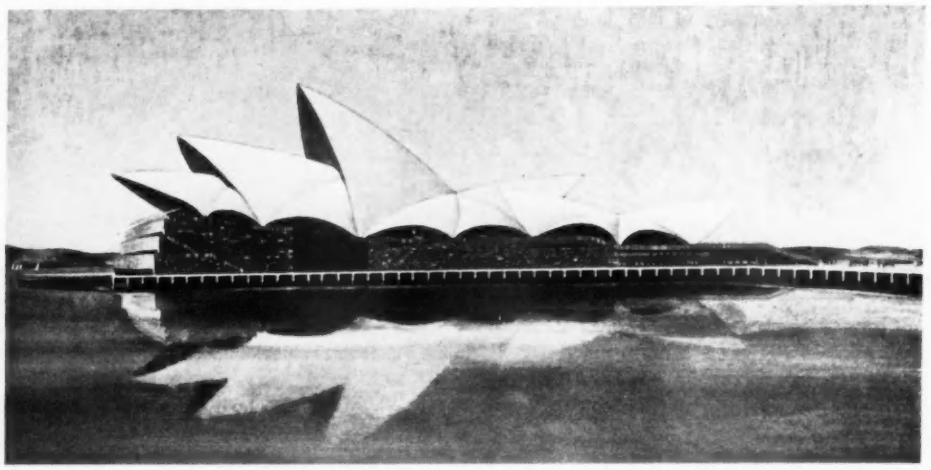
In these circumstances, the appearance of a new book on acoustics, written for architects by an internationally famous worker in this field, is particularly welcome. Professor Furrer who wrote the book is head of research and development in the Swiss P.T.T. As the leader of a research team and a sensitive listener, his views are of particular value. He has not only been responsible for the acoustic design of most of the broadcasting studios in his country but has a wide experience as a consultant to building projects of all kinds. Having travelled widely, he knows many of the important concert halls in Europe and America and his book is remarkable for the detailed descriptions and fine photographs of concert halls, theatres, broadcasting studios and other enclosures requiring special acoustic treatment. Much of the book is necessarily devoted to the basic information on the properties of sound which is required by an architect who wishes to know not only what he should do but why he should do it. The first section, on fundamentals, includes an exceptionally clear exposition of the rather complex ideas of the subjective loudness of sounds and the summation of noise. There is also useful information, not collected elsewhere, on the effects of terrain and local surface features in the protection of buildings against extraneous noise. A later section, on insulation against air- and structure-borne sound, is well illustrated with diagrams of successful and economical methods of construction.

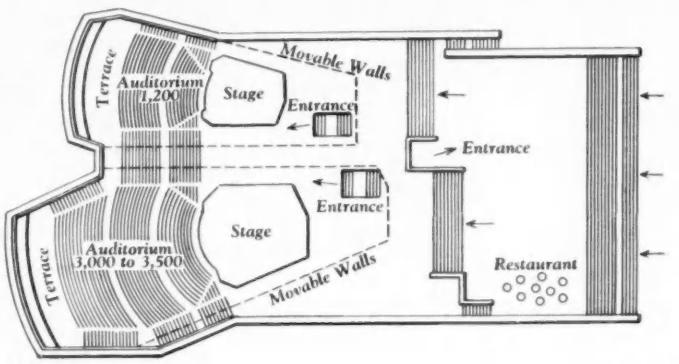
It is, however, in the sections on acoustic design that the book becomes most individual and most valuable. He gives few positive judgments on the qualities of the particular buildings which he describes, but his general rules and the details of his own designs show clearly the point to which his thought and experience have led him. For instance, his hall at La-Chaux-de-Fonds is a modern version of the traditional *Gewandhaus* type, retaining the shape but replacing the ornamentation of the previous period with modern coffering forms designed to have the same acoustic effect.

A concert hall designer is usually forced by indirect economic pressure to make the seating capacity as large as possible, for a symphony orchestra is so costly that enormous paying audiences are necessary. Here a conflict arises with acoustic considerations; in a hall of given size, the audience, which is the principal sound absorber, cannot be increased beyond a certain number without reducing the reverberation time below its optimum value; and, on the other hand, the dimensions of the hall cannot be increased indefinitely to compensate for this without spoiling it for solo voices and instruments, and introducing disturbing time delays and echoes. Professor Furrer concludes that the largest hall capable of giving entirely satisfactory acoustics is one of 10,000 to 15,000 cub. metres, seating an audience of not more than 1,600 to 1,700. This appears perhaps a pessimistic estimate, remembering that St. Andrew's Hall, Glasgow, seats 2,600 people in a volume of 16,000 cub. metres and yet achieves a reverberation time of 1·9 seconds, with an unequalled reputation in this country for tonal quality and definition. This difference may arise from the fact that a "directed sound" hall sounds less reverberant than one of traditional shape.

A similar compromise is necessary for an opera house. Some fullness of tone must be sacrificed for intimacy and clarity of diction, and indeed the design of the Eighteenth Century opera houses had a profound effect on the style of composition. Professor Furrer considers that the volume should not exceed 5,000 cub. metres if the stage is to be easily seen from all parts, and an audience of 1,200 to 1,500 would be the maximum for the satisfactory presentation of the music. The upper limit of size is probably reached by La Scala Opera House in Milan, and the Royal Opera House, Covent Garden, each seating over 2,500.

While one may disagree with these particular estimates, one can have no doubt that maxima of this order exist. The recently announced



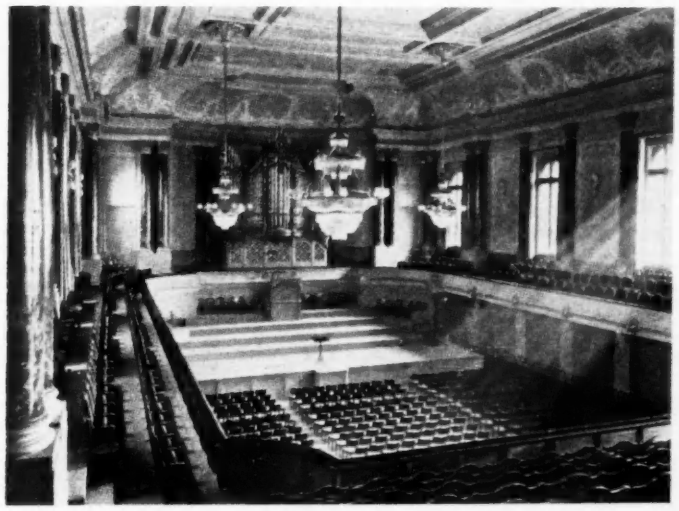


(4295) "ENGINEERING"

The proposed new Opera House for Bonolong Point, Sydney, Australia. Its layout and design ignore all the known requirements for the worthwhile presentation of symphonic music or opera. The complex concrete shell vaults are intended, according to the architect, "to contrast with Sydney's square buildings."

proposals for a new opera house to be built on Bonolong Point in Sydney therefore come as an unwelcome surprise. The design, which will be based on the winning entry in an international competition, will comprise two halls, the larger seating 3,500 and the other 1,200 people. In each case the whole of the seating is accommodated on a single raked floor. Both halls, as will be seen from the drawing, have fan-shaped plans tapering towards the stages and relatively low ceilings shaped to direct first reflections on to the rear seats. They are separated by sound-insulating walls which can be removed to transform the whole space into one vast arena.

The fact that the whole audience is accommodated in one floor means that the plan area will be large and sight lines long; the length of the larger hall from the back seats to the centre of the stage appears, in fact, to be of the order of 160 ft. In the absence of more detailed information, it is hard to avoid the conclusion that the large hall will be totally unsuitable both for symphonic music requiring a reasonably long reverberation time and for opera which above all needs short sight lines, good intelligibility and freedom from echoes. If scientific inquiry has achieved anything, this design, which ignores or rejects the whole body of past experience, is hardly likely to be a success. The judges, in announcing the award, emphasised that the design which is finally adopted may not follow the winning entry in all its details, though it will do so in its general lines. If it is not too late, it is to be hoped that the authorities concerned will take due note of Professor Furrer's remarks and make some far-reaching changes.



The Basel Casino Hall. In spite of, or indeed because of, its rectangular shape and Victorian ornamentation it is a fine concert hall.

★ ★ ★

A PATTERN FOR ELECTRICAL MACHINES

The General Theory of Electrical Machines. By BERNARD ADKINS. *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (45*s.*)

In spite of the immense developments in the design, construction and control of electrical machines, it is felt by most students and many teachers of electrical engineering that, in principle at least, all is known about such devices. For good or ill, and mainly for good, power engineers do not engage in publicity campaigns. However, not only has there been an absence of publicity, there has also been a most regrettable absence of authoritative books on electrical machines. Mr. Adkins has now written such a book. Not only teachers, but machine designers, system and control engineers have all been presented with a valuable new tool.

It is a valuable book and it has come at an opportune time. The author modestly claims that much of his material is derived from American papers. This is true in principle, but it is not the whole truth. Only those who have struggled through many of the papers listed in the useful chronological bibliography at the end of the book can appreciate the immense amount of clarification carried out by the author. The difference between some of his sources and his own book is similar to the difference between the taste of a bag of flour and a freshly baked cake.

Unlike some of his predecessors, Mr. Adkins does not treat his readers as having the gift of second sight or as being mentally retarded. The first chapter introduces the reader to the general theory without wasting words, and with great clarity. The similarity in the windings of different machines is stressed and it is shown how an " equivalent " machine can be built up by combining any number of such windings. This equivalent machine forms the basis of the author's theory.

Having introduced the concept of such a machine the author proceeds to derive the circuit equations for it. He then makes a survey of the methods of solution that are now available for both steady-state and transient conditions of operation. Many of these problems have long been well defined, but could not be solved because of the labour of computation. Computers and analysers can now make such solutions available. There follow two chapters, on direct-current machines, which are well designed to acquaint the reader with the use of the equivalent machine in a familiar setting. Moreover, the treatment serves as an admirable bridge to the discussion of machines in control systems. The next chapter, on the steady-state vector diagrams of alternating-current machines, seems almost out of place in a book on general theory. But how grateful we must be that it has been included. It should be made compulsory reading for all teachers of electrical machinery whether it be for national certificate or degree courses. To tackle a familiar subject as this with such freshness and clarity shows the author to be a master teacher.

After this chapter many readers will be on unfamiliar ground. The author derives the general equations for alternating-current machines, dealing in some detail with squirrel-cage windings and damper windings on synchronous machines. The simplicity and convenience of the matrix notation used by the author becomes increasingly obvious. Designers of synchronous motors will rejoice to see the treatment of the rather intractable torque-speed relationship of synchronous motors dealt with so clearly. There is also a satisfying introduction to the equivalent circuits of synchronous machines. There is not space to mention all the good things contained in this book. Among these are the analysis of hunting and synchronising oscillations, and an introduction to the choice of machine constants in problems of power system analysis. Then follows the last chapter and this opens an almost unlimited field of application of the theory of the general machine to a host of different machines. Some matrix algebra is needed to understand this chapter, but it will be found most rewarding to acquire such an understanding. The method of the connection matrix is powerful in bringing about a synthesis both of concept and mathematical structure. Rotating electrical machines are shown to be amenable to identical methods of analysis, whatever their differences of construction.

It is certain that this method will capture the imagination of teachers and students alike. In fact its very success may prove to be its undoing. Already some writers, less experienced in machine design than the author, are advancing ludicrous claims on behalf of this generalised theory. It has been hailed as the great new fact of science. Mr. Adkins may find himself surrounded by a group of eager disciples who would wish to make his last chapter into his only chapter. Such people will find that instead of understanding more about electrical machines they will only understand more about algebra—an algebra that may or may not be relevant to practical engineering problems. Perhaps a less ambitious title might have served this book better. An algebraic treatment without reference to electromagnetic principles cannot really constitute " the general theory " of electrical machines.

But we do not wish to criticise this book for what it is not. It will remain for many years a classic treatment of the subjects the author handles so admirably.

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NEW BOOKS

The Design of Belt Conveyors. *Mavor and Coulson, Limited, Bridgeton, Glasgow, S.E.* (42*s.*)

By the use of alignment charts the various design requirements for belt conveyors can be calculated. The factors included in the charts of the volume are capacity, gradient, power required to drive, loading and unloading, together with the size of the belts for particular applications. At the end of the book there are examples of different types, so that the method of using the charts can be observed. The tables include a density table for nearly 120 materials and the text is well illustrated with diagrams and photographs. Distribution is restricted.

Planetary Gearing (Design and Efficiency). By H. W. HARDY. Machinery's Yellow Back Series No. 37. *The Machinery Publishing Company, Limited, National House, West-street, Brighton*, 1. (4*s.* 6*d.*)

Planetary gearing is a subject which frequently gives trouble both to the student and the junior engineer. This book has been written to indicate a clear method of approach, with the purpose of enabling the reader to solve more readily the problems which occur.

Vibration Analysis Tables. By R. E. D. BISHOP and D. C. JOHNSON. *Cambridge University Press, Bentley House*, 200 *Euston-road, London, N.W.*1. (10*s.* 6*d.*)

The volume gives tables for the vibration analysis of torsional systems having 1, 2 or 3 degrees of freedom, the receptances of composite systems and vibrations, lateral, torsional and longitudinal for shafts, bars and beams. Also included are characteristic functions and derivatives for use with the tables. The tables have been extracted from the book by the same authors, entitled " Mechanics of Vibration."

Précis d'Énergie Nucléaire. By G. CAHEN and P. TREILLE. *Dunod*, 92 *Rue Bonaparte, Paris* (6*e*), *France*. (2,800 *francs.*)

In the preface, the French High Commissioner for Atomic Energy very aptly describes this book as being of inestimable value in speeding up the training of specialist engineers for nuclear energy development in France, as well as to students. Written by two eminent French nuclear physics professors, the book surveys in detail, most lucidly, the basic principles of the Atomic Theory. Without delving too deeply into mathematical aspects of the problem, the phenomena involved are rapidly reviewed to provide the background essential for understanding the functions of atomic piles, the various types of nuclear reactors, radioactivity and shielding, including technology and types of materials applicable to this particular field. One chapter discusses radiation hazards, detection, methods and equipment employed in reactor control. Another extremely important chapter is one discussing present progress and future prospects of nuclear power station development and atomic propulsion for ships and aircraft. To round off the subject there is a chapter on the products of radiation, radiography, industrial applications and controls and radioactive tracer techniques.

Marketing

ENTERPRISE IN CANADA

Three British companies, W. H. Dorman and Company, Limited, F. Perkins Limited, and Black and Decker, Limited, and one British subsidiary of a United States company, IBM United Kingdom Limited, have recently provided information on their activities in the Canadian market. There are few countries which are able to expand at such a high rate by means of the most advanced equipment and machinery.

IBM United Kingdom have installed a computer in Montreal which will be linked by telegraph to railway stations and yards across the Canadian Pacific Railway system. It will deal with the whole complex wage payments for over 70,000 employees and with the recording and analysis of freightage, material purchases, accounting, stock control and employment. It will be concerned with the daily movement and co-ordination of thousands of freight cars. W. H. Dorman have installed several hundred Diesel engines driving generators which supply current to all the stations of the 3,000 mile mid-Canada radar defence line which went into operation earlier this year. The company have been developing the Canadian market intensively over the past few years, and it is now one of their " most important and promising."

Black and Decker, who have for some time found the Canadian market very lucrative for their portable power tools, have purchased a factory in Brockville, Ontario, where initially they will make their electric motors and assemble their full range of tools which will eventually be made there. One of the main factors leading to the decision to set up a manufacturing unit was the " considerable local growth of interest in ' do-it-yourself ' activities." F. Perkins's Canadian subsidiary, which is a sales and service organisation, exceeded 1 million dols. in turnover for the first time since it was set up in 1952. The success of these companies is clear evidence of the vast opportunities that await the enterprising British firm in Canada.

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New American Licence

The licence to manufacture the vacuum furnaces and ancillary equipment designed and produced by NRC Equipment Corporation of Newton Highlands, U.S.A. (a subsidiary of National Research Corporation) has been acquired by Wild-Barfield Electric Furnaces, Limited. In addition, Wild-Barfield have been appointed exclusive resale agents for all NRC Equipment Corporation high-vacuum components, packaged systems and other standard products.

The rapid growth in the use of vacuum melting in titanium, high-temperature alloys, bearing steels and nuclear materials has been Wild-Barfield's principal consideration in negotiating the licence. In this case, as in many others, the design of the equipment from scratch would have required considerable resources and much valuable time. NRC Equipment Corporation enjoy a world-wide reputation in the industrial high-vacuum equipment business, and the association will doubtless greatly benefit the British company. On the other hand, the dollar shortage remains and, so long as it does, United States firms will continue to find it convenient to have made in Britain—under licence or by subsidiaries—machinery and equipment for markets in the sterling area.

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Europeans in New York

The keen interest of both western and eastern Europe in the rich and growing United States market was in evidence at the United States World Trade Fair in New York last month, where Europeans accounted for a large proportion of the 3,000 exhibitors. Britain, France, Italy, the Netherlands, Switzerland and many others showed the newest and most exotic of their specialities. National pavilions designed to represent the picturesque and the traditional in each country were prominent, even in the case of eastern European countries such as Poland and Yugoslavia. Czechoslovakia exhibited glassware, small printing machines and other specialities which attracted much attention.

Western Europe did not have the whole show to themselves, by any means. Japan's Export Trade Rehabilitation Organisation was the largest exhibitor, and crockery their main exhibit. Japanese exports of crockery to the United States rose from 1·9 million dols. in 1955 to 4·8 million dols. last year. India was the other big exhibitor from the Far East, showing mainly rugs, textiles and brassware. There is little doubt that hand-made goods have considerable appeal but that the cost of these articles from western Europe tends to be too high even for Americans.

The Fair was a success for British firms. Some 130,000 buyers came from all parts of the country and good business was reported by manufacturers of modern furniture, portable domestic power tools, electric space heaters, office machinery and many other products. In addition to the buyers, some ¾ million of the public visited the Fair during its two weeks.

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G.E.C.'s Export Guide

The April issue of the General Electric Company's Export Guide indicates some important changes in the outlook for British goods in several markets. In general, export prospects continue to be favourable and good performance is expected during the coming months. Prospects in 34 countries analysed in the guide are good in 14 of them, " improving " in six, " deteriorating " in ten and " bad " in four. Between January and March this year, trading opportunities have improved in Burma, Iraq and the Soviet Union, and are now good in Italy, Malaya and Singapore, Norway and Trinidad. They have deteriorated in Ceylon, India, Sweden and the United States, and are now bad in the Republic of Ireland, Portugal and Spain.

The Guide includes a detailed survey of Commonwealth trade which analyses the importance of these markets in relation to total British exports, and shows changes that have taken place over the past seven years. A particularly interesting feature of the analysis is the successes it reveals in the export of six products of " new or expanded industries." There is also a section devoted to a review of the more important new developments in the emerging European Free Trade Area, which was the subject of a special study in the January issue of the Guide.

This regular analysis of economic and industrial trends in the principal British markets is proving more valuable than was originally expected. This is the kind of guidance which should have been provided years ago by the Board of Trade.

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More Mobile Exhibitions

The use of mobile demonstration units is growing rapidly in the engineering industry. The Skefko Ball Bearing Company, Limited, have announced that a unit consisting of a truck and trailer is touring the Lancashire mills to give on-the-spot demonstrations of SKF textile machinery drafting equipment.

The unit is equipped with a petrol-driven generator which provides current to drive all the demonstration models when they cannot be connected to the local mains supply. The trailer is air conditioned and has facilities for the showing of films and slides. The problem of accommodating all the necessary spinning and testing equipment has been overcome by the use of telescopic sides to the trailer, which enable it to be extended from 7 ft. 3 in. to 13 ft. 6 in. It has a roomy conference room and sleeping quarters for the crew. The company's comment, that " the most effective method of publicising SKF products to the textile industry is to arrange a series of demonstrations at the mills," has been made in various ways by other firms. Mobile demonstration units have now a place to themselves in modern selling techniques.

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Achievements of G.A.T.T.

This year is the tenth of the operation of the General Agreement on Tariffs and Trade (G.A.T.T.). Mr. Eric Wyndham White, the executive secretary, reviews progress in a comprehensive article published in the March issue of the *United Nations Review*.

G.A.T.T. began in a great deal of controversy and its achievements have on the whole been far greater than even the most enthusiastic supporter of freer trade had dared to hope. To quote Mr. White, it is to-day " firmly established as an international institution enjoying widespread support." The work of the first ten years is expected to be crowned by the formation of the Organisation for Trade Co-operation, which is to come into operation next October.

The influence of G.A.T.T. on national policies has steadily increased, but to some extent at least it has been in harmony with a trend towards trade liberalisation—backed vigorously and consistently by the United States, and now by Western Germany. As Mr. Lewis points out, success has been achieved in " years of expanding trade and growing prosperity." To free trade in other circumstances might have been more difficult. Still, the acceptance of the basic philosophy of the Agreement has grown wider and the habit of round-table consultation in trade matters has been acquired by most of the countries of the world. These are most positive gains and augur well for the prospects of the Organisation for Trade Co-operation.

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Combined Display at Poznan

A new organisation, United Construction Machinery Company, Limited, has been formed as a sales syndicate to handle the sales of nine companies in eastern Europe. Participation in the Poznan Fair, where they have booked 500 square metres, will be the new company's first attempt to concentrate the sales effort of leading companies who make complementary equipment and machines in the field of building construction.

To some extent the formation of U.C.M.C. was the result of the trading practices that prevail in eastern Europe, where most countries have adopted the trade delegation system, whereby a single organisation buys on behalf of each industry. Among the equipment to be displayed will be direct air compressors (Mackay Industrial Equipment); four-wheel-drive loading shovels (W. E. Bray); vibrators (E. P. Allam); industrial 8 b.h.p. Diesel tractors (Ransomes, Sims and Jefferies); excavators (Priestman Brothers); tracked tractors (Marshall Fowler Group); weigh-batching, monorail and dumper equipment (Road Machines (Drayton)); and hoists (A.C.E. Machinery).

Such an approach to the problems of selling abroad is not new but has been tried so far by very few industries. It offers considerable potential not only in Eastern Bloc countries but wherever selling is difficult and expensive for single firms to tackle.

SERVICING TWO MILLION VEHICLES

There has recently been completed at Aveley in Essex, a spares and parts depot for the Ford Motor Company. This is one of the major projects involved in their extension programme announced in October, 1954. Other items include a new press-shop for Briggs Motor Bodies, Limited, a new assembly building at the Dagenham works with a floor area of 700,000 sq. ft. and a new foundry building, also at Dagenham, covering 260,000 sq. ft., besides other work there and projects at Basildon and Leamington.

The spares department depot is the first item in the programme to be completed and brings together, in one centre, work that was previously carried out in 12 different localities. Both offices and stores are in the same building. The home deliveries have been speeded up from four weeks to one, and overseas orders to about two weeks. It is expected that shortly a 24-hour dispatch service for emergency orders will be in operation. To supply the 2¼ million British Ford vehicles that are now in existence, a stock of 31,500 different items is maintained at Aveley and orders are being handled at the rate of approximately four millions a year. The building was laid out to suit the storage system chosen, and the framework built around the floor plan. It covers an area of 362,000 sq. ft. (with the offices making a total of 434,400 sq. ft.); 40 per cent. of the site is as yet undeveloped.

Incoming spare parts, whether from one of the Ford factories or parts bought from other manufacturers, are brought by road to the unloading docks, of which there are five. Three of these are equipped with metal ramps which can be raised or lowered hydraulically to suit the floor level of the incoming vehicle. In this way mechanical trucks of the pallet or fork lift variety can be run direct into the vehicle to remove the parts. Across each double truck bay is a 30 cwt. travelling hoist as an additional handling facility.

Parts arriving are subject to inspection, either on a percentage or total basis as experience has shown is necessary, and those which are liable to rust are dipped in an immersion tank containing inhibiting fluid, by an overhead conveyor. Parts arriving in pallets are taken to the inspection department, and then removed by the trucks for storage in pallet racks. Smaller parts after inspection are loaded on to trolleys which are taken by the Towveyor system to the storage racks. This system passes down most of the main aisles in the depot. The smaller items are loaded into bins and the larger ones either on to tubular-steel racks or else are kept in pallets in another storage section. In some cases it has been found convenient to pack smaller items in units of 10 or more, according to the demands that have been experienced in the past. Stock ordering is based on experience of the demand for each item; in the case of new models, a stock of spares is started simultaneously with the model going on the market.

When an order is received it is passed to the office where it is duplicated on punched cards with Powers Samas equipment, and thence to the clerks in the storage section. The pickers collect their order sheets from the clerks and proceed to collect the items on to a trolley. The arrangement that has been found to work most satisfactorily is for each picker to deal with a certain section of the storage area. In this way he can become familiar with the items concerned, and does not have to adventure into fields unknown. Items are located by the number of the bin or rack, which is noted on the punched card against the part number. When the trolley has been loaded it is connected to the Towveyor system, simply by dropping the bolt to connect with the coupling on the moving chain, and is then delivered to the dispatch department. Uniformed security officers make test checks on consignments before they are packed, as a guarantee of correctness.

Fig. 1 Adjustable ramps, hydraulically operated, allow the handling trucks to run direct into the lorries.

Fig. 2 Hand trolleys are used to move the smaller parts within the stores, and when loaded are connected to the Towveyor system which takes them to the dispatch section.

Parts are packed either in cartons or cases according to their size and destination, and are delivered to the five outgoing bays. Movement within the area of those parts stored in pallets or which are larger than can be handled on the normal Towveyor trolleys (there are two sizes of these, one which will carry half a ton and the other two tons) are handled by different types of fork lift trucks. For the main areas there are electrically-operated Stacatrucs capable of lifting 4,500 lb. and for the narrower aisles there are Lansing Bagnall reach trucks with capacities of 2,500 lb. and capable of working in aisles only 7 ft. wide. Yale and Towne Work-saver pallet trucks are used as well, together with hand-hydraulic Omic and I.T.D. Portapals.

To improve the operation of the packing department it has been found of advantage to allocate specific destination areas to particular operators. They then become familiar with the requirements for these areas (such as special woods for the cases to prevent the introduction of infection, waterproofing, de-hydrating and the like) and can deal with the parts more rapidly. They are not confined solidly to one area, however, and a certain amount of change is introduced to prevent boredom.

As far as possible mass production methods have been used; for example cases are made in a range of standard sizes. Mechanical hammers are employed in nailing up ends and sides, and for all light work cartons are used which are mechanically banded and closed. The depot is maintained at a standard temperature by 41 overhead Dravo heaters burning fuel oil. These are automatic in operation and the opening of a door can be sufficient to start one working. "Up and over" mechanically-operated doors are used to conserve the heat. The office block is heated from two oil-fired boilers which also supply hot water for services. About 810 men and women are employed in the stores proper, and 410 in the offices.

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PRODUCTIVITY FILMS

Three films were recently shown in London by the British Productivity Council, 21 Tothill-street, London, S.W.1, each dealing with a separate aspect of productivity. The first described the work of the local productivity committees, showing in particular, the operation of the "Circuit." Members within the Circuit visit each other's factories for the purpose of obtaining new ideas and generally stimulating interest. The idea behind the institution of the Circuits is summed up in the words "Should you and I have one idea apiece and share them, then we should each have two ideas."

The second of the films dealt with work study, and in particular its application to team work. The film was made in conjunction with the Hot Dip Galvanizers Association and shows in particular how the galvanizing of tanks can be made a subject for work study. It is shown how, by analysis and constructive criticism, the efficiency of small batch jobs can be improved.

The third of the films shown was entitled "The Unforgiving Minute" and as the title suggests, dealt with the question of time measurement. Time costs money, and until the amount that will be used is known, the total cost of an article cannot be accurately estimated, nor can continuous production be planned. The film explains in very simple terms how by timing, rating and allowing for rest and other contingencies, work can be measured. It does not deal at all with incentives or bonus schemes.

All three films are available on loan from the Council at the above address.

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MACHINING DIFFICULT MATERIALS

Originally developed as a drilling lubricant for a very tough stainless steel, R.T.D. compound, a product of Rocol, Limited, Swillington, near Leeds, is now being applied to many different materials, ferrous and non-ferrous, such as stainless and other alloy steels, nickel, light alloys, titanium, and plastics. It is being used as a lubricant for all types of machinery in addition to its original drilling application, and also for deep drawing of sheet components and for wire drawing.

The compound, which has a balanced content of additives, is, in fact, suitable for all types of operation where extreme pressures bear on the tool and frictional heat, galling, scuffing, wear and seizure are also experienced. It is in liquid form and can be applied by brush or oil can, or, where a flow of lubricant is necessary it can be mixed with paraffin or light cutting oil.

Extensive field tests have been conducted on various materials and different types of machining operations, and substantial improvements in tool life, in material finish, or in both, are claimed.

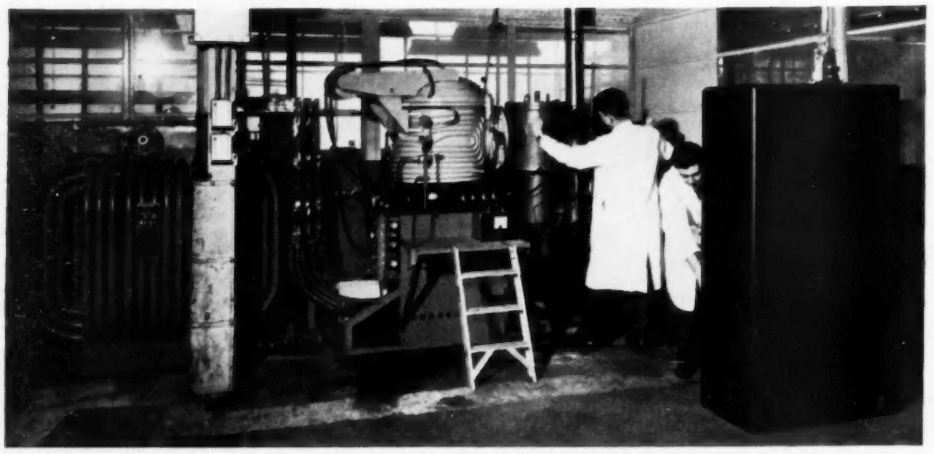


Fig. 1 Graphite-resistor vacuum furnace designed to give temperatures of up to 2,000 deg. C., and to be used for sintering. On the left is seen the transformer, in the centre the furnace, on the right the pumping system and on the extreme right the control panel.

ELECTRICAL VACUUM FURNACE FOR HIGH-TEMPERATURE WORK

POWDER-METALLURGY APPLICATIONS

Graphite-resistor vacuum furnaces capable of providing temperatures of up to 3,000 deg. C. have been developed by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. They meet the demand, created by development work on atomic-energy equipment, guided weapons, and supersonic aircraft for high temperatures required in the heat treatment of the metals titanium, tantalum and zirconium; for sintering; and for brazing components which are to operate at elevated temperatures.

One of the first of these new high-temperature furnaces has been installed in the research powder-metallurgy laboratory of the B.S.A. Group at Small Heath, Birmingham. It is seen in Figs. 1 and 2 on this page. Designed to give temperatures of up to about 2,000 deg. C. and to maintain a good vacuum for the protection of a charge from oxidation, it is to be employed for sintering materials for use at high temperatures. The body of the furnace is a water-cooled, vertical, cylindrical steel tank with a hinged, domed lid. A vacuum-tight seal is formed between flanges on the lid and the furnace body. The charge is heated by radiation from a triangular-shaped assembly of graphite bars which surrounds the charge space. These graphite bars operate at a low voltage supplied by a three-phase transformer. A voltage regulator enables the secondary voltage of this transformer to be steplessly varied to give control over the heating rate.

Radiation screens, consisting of molybdenum sheets arranged in such a manner as to enclose the heating chamber, provide the thermal insulation. With the furnace lid raised the upper radiation screen can be lifted to give access to the chamber. The charge is supported on a graphite tripod.

The vacuum pumping system consists of a gas ballast pump, a combined booster and oil diffusion pump, and a valve block which controls the evacuation of the furnace chamber. The valve block is fitted with a five-position operating lever which can be moved only in one direction to ensure the right sequence of operations. With the lever in the first position, air is allowed into the furnace chamber and the pumps can be switched on. In the second position, the chamber pressure is reduced by the course pump, and this evacuation continues in the third lever position—similar to the first lever position, except that air is not allowed into the chamber—until the pressure has been reduced to 0·05 mm. mercury. With the lever in the fourth position, the diffusion pump continues the evacuation until the required pressure is reached. An operating vacuum of between 10^{-4} mm. and 10^{-5} mm. mercury can be obtained. When the lever is in the fifth position, all the valves are closed so that the furnace chamber is isolated from the pumping system, and leak-rate tests can be made.

Safety devices give protection to both the furnace and the charge against possible failures in the electric and water supplies. Warning of an electric-supply failure is given by an audible alarm. In the event of a fault occurring in the flow of the water-cooling system, relays cause an interruption in the power supply to the furnace. An indicator lamp in each cooling circuit simplifies the location of a fault.

The maximum rating of the furnace is 120 kVA; it will take a charge approximately 9 in. in diameter and 12 in. high with a maximum weight of 90 lb. With an alternative element arrangement the charge space can be increased to 11 in. in diameter by 11 in. high. Provision is made for introducing a hydrogen atmosphere into the furnace chamber to hasten the later stages of cooling. In this manner, when using the furnace for brazing a 50 per cent. reduction in cooling time can be obtained.

The firm also make furnaces of the same design having loading dimensions 4 in. in diameter by 6 in. high, for laboratory use, and larger units having loading dimensions 15 in. in diameter by 24 in. high.

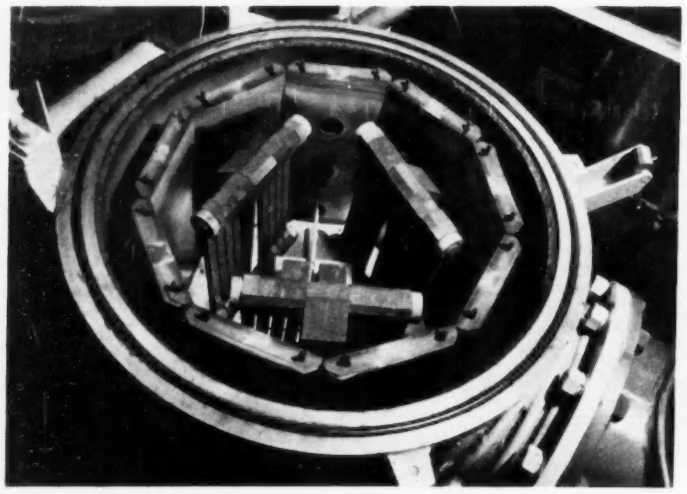


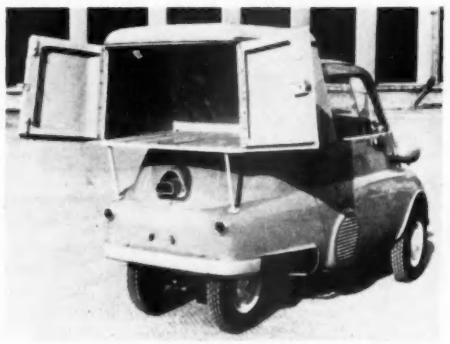
Fig. 2 The triangular-shaped assembly of graphite-resistor heating bars is seen surrounding the charge space. Radiation screens, consisting of molybdenum sheets arranged in such a manner as to enclose the heating chamber, provide the thermal insulation. When the furnace is opened, the upper radiation screen is lifted and housed in the domed lid so as to allow free access to the chamber. The charge is supported on a graphite tripod.

★ ★ ★

B.M.W. ISETTA CAR

Britain's latest car factory has no access to a road save by a flight of steps. Commencing in May the B.M.W. Isetta is to be made in the former British Railways locomotive works in Brighton and the only vehicle access to it is by rail. Every week-end a train will steam into the factory bringing sufficient parts for up to 250 Isettas, and twice a day during the week, wagons loaded with new Isettas will be drawn out, to be attached to trains for London, where the central distribution depot is situated.

The company making these cars in England,



formerly known as Dunsfold Tools, Limited, has changed its name to Isetta of Great Britain, Limited. It has an exclusive licence to make and sell the cars for the British Commonwealth. At first 54 per cent. of the components will be British made, but the ultimate aim is complete British manufacture. There are six models, including coupé, convertible, and two commercial vehicles with boxes for goods mounted on the back, to give a total load capacity, including driver, of 500 lb. Later there will also be an Isetta invalid carriage. Right or left hand drive will be supplied.

British components include Lucas 12 volt electrical equipment, Dunlop wheels and tubeless tyres, Rubery Owen chassis frame and suspension parts; springs, dampers and hydraulic brakes by Girling; and Burman steering. The B.M.W. 300 c.c. engine, transmission and body pressings are at present imported, together with other parts not yet available from British suppliers. The first thousand of the British-built cars have been ordered for Canada and will be fitted with extra-large bumpers and tail lamps to meet local requirements. Since manufacture was arranged in England, prices have been sharply reduced on the British market. One of the goods vehicles is illustrated above.

BRITISH GUIDED MISSILES

At least four British guided missiles are now known to be in production—two air-to-air and two surface-to-air weapons. The information released on these weapons is still, however, very restricted. As disclosed by recent announcements Fireflash, the air-to-air " beam rider " developed by the Fairey Aviation Company, Limited, Hayes, Middlesex, announced last summer (ENGINEERING, September 21, 1956, page 372), is shortly to go into full-scale service trials on Swift 7 aircraft using converted Meteor " drones" as targets.

FIRESTREAK

A more advanced air-to-air missile, Firestreak, is about to go into production. This weapon will be fitted to the English Electric P.1 and Gloster Javelin fighters. Developed by de Havilland Propellers Limited, Hatfield, Firestreak is shown, accelerating rapidly immediately after launching, in Fig. 1, taken by a camera mounted in the wing of the parent aircraft, which was flying at great height.

Firestreak employs infra-red target homing, a system which, offering great range and sensitivity, has the great advantage of immunity from the jamming which it is possible to employ against conventional radar weapons. The system employs a detector " eye " which is sensitive to the infra-red rays emitted from an aircraft; this eye, once it has locked on to the target, feeds information into the control system to ensure that the weapon continues to travel in the correct direction, no matter what manoeuvre the target may perform.

The components of Firestreak fall into six main sections: the guidance, control, and fusing systems, the power supply, the propulsion motor, and the warhead; they are housed within an aerodynamic body tube fitted with four small wings and four control fins. The parent fighter aircraft carries Firestreak on a launching shoe attached to the wing of the aircraft. Weapons may be fired singly or in pairs, and provision is made for jettisoning them in an emergency. The ancillary equipment required in the parent aircraft has been designed and developed also by de Havilland Propellers Limited.

The main design requirement specified by the Ministry of Supply when the development contract was awarded was that the weapon should be reliable and easy to handle in service. At an early stage of the work, therefore, de Havilland Propellers Limited decided to design and manufacture all components of the weapon themselves, with the exception of the propulsion and explosive units which could be produced by existing facilities within Government establishments. This decision, the company consider, contributed largely towards achieving the final results in the shortest possible time.

The first complete Firestreak was fired at Larkhill, the launching being carried out at night from the ground. The target, several miles distant from the launching site, took the form of a large wire frame which carried heaters to simulate the radiation from an aircraft. A direct hit was scored.

The air trials of Firestreak began during the middle of the ground launching tests, over the Aberporth range off the coast of Wales. After a series of tests to prove that the weapon could be jettisoned safely and effectively launched to follow the desired flight pattern, a radio-controlled target aircraft, fitted with heaters to simulate radiation from a modern aircraft, was put into the air, and a Venom fighter, equipped with Firestreak, set off in pursuit. The weapon was launched and scored a direct hit on the target, which crashed into the sea. A continuous programme of air firing has since been carried out at Aberporth, and at Woomera, Australia, using a Jindivik high-speed target aircraft developed by the Government Aircraft Factory in Australia.

Production of Firestreak is taking place at Walkden, near Lostock, where a large factory

Fig. 1 Firestreak, the air-to-air guided weapon with infra-red homing.

is nearing completion beside the company's existing factory which itself has been extensively re-equipped. The new factory will be used solely for the assembly of Firestreak.

BLOODHOUND

The Bristol/Ferranti Bloodhound, a new British supersonic surface-to-air guided missile, powered by Bristol ramjet engines, will in due course replace fighter aircraft for the defence of the United Kingdom.

Bloodhound has been designed by the Bristol Aeroplane Company, Limited, Filton, and Ferranti Limited, Manchester, in collaboration with the Services, to be uncomplicated to maintain; flight trials have shown that it is reliable under operational conditions. The missile has been designed from the start as a set of packaged interchangeable components.

The Bristol Group of Companies and the Lancashire electrical engineering firm of Ferranti have been working together on the development of guided weapons for the air defence of the United Kingdom since 1949; the two firms now have one of the largest combined workforces on guided weapons in Europe. Four Bristol and two Ferranti factories are heavily committed to various forms of guided weapon production for the British government, the most important single activity being the development and production of surface-to-air missiles for Service use.

Bristol Aircraft, Limited, have borne the overall responsibility of the successful development of Bloodhound, i.e., the complete defence system, not merely the surface-to-air missile. Bristol Aero Engines, Limited, have concurrently developed and are now producing the ramjet power units used to drive the missiles; Ferranti, Limited, have designed, and are producing, the intricate radar and servo-control equipment needed to guide the weapon automatically to its target.

The development of the weapon has proceeded from the outset without major re-design, and for this reason photographs of early missile tests cannot be reproduced, because they would show too much classified information.

The missile system operates in the following way: radar stations at strategic points around the coast give early warning of the approach of enemy aircraft; this information is passed automatically to the control post of the nearest battery of missiles. The control post automatically assesses when the target is within range and sends out signals which fire off as many missiles as necessary. The system could differentiate between one aircraft and two flying in close formation, thus permitting each to be attacked separately.

The power source for Bloodhound is a Bristol ramjet engine of the Thor type—a unit developing great power at very high speeds in the upper air. Extensive flight testing of the engine has been undertaken at the Aberporth and Woomera ranges, making use of over 200 test vehicles. Because ramjets operate efficiently only at supersonic speeds, the vehicles are given an initial boost by rockets which accelerate the missile from rest to more than 1,000 m.p.h. in a few seconds during which time the ramjet starts and attains full power.

The engine is now fully developed, fully reliable and ready for service. Ramjet power, it is claimed by Bristol, gives great flexibility of operation which cannot be matched by a rocket-powered missile. The ramjet uses only about one-tenth of the propellant required by a rocket and therefore makes possible extremely long range interception. The speed and altitude capability of the ramjet-powered missile are comparable with those of the rocket; the ramjet can also fly at high speed at low altitude.

In the Ferranti laboratories, after extensive research, have been designed and developed the radar and electronic circuits, servo-mechanisms, gyroscopes and other highly specialised equipment which control the weapon in its flight. Among the many specially designed test rigs is the most powerful testing plant of its kind in Europe. By using this equipment, a missile

Fig. 2 The drop tower for shock-loading missile components at the English Electric test facilities.

can be subjected in the laboratory to the fierce and destructive vibration conditions met in supersonic flight, and under which these intricate control devices must function faultlessly. Ferranti's printed electronic circuits have proved of great value in solving the crucial problem of reliability, on which the success of guided weapon defence so largely depends.

ENGLISH ELECTRIC'S MISSILE

Another surface-to-air weapon system, in this case with rocket-propelled missile, has been ordered from the English Electric Company, Limited, for the British Armed Forces—whether for launching from land bases or from ships has not been disclosed, and the missile is, as yet, nameless. Production has already commenced. The English Electric Group are entirely responsible for this weapon system: the rocket motors are to be constructed by D. Napier and Son, Limited; the electronic equipment by Marconi, and the aerodynamic work, computers for the guidance system, and electrical gear by the English Electric Company, Limited. A composite team from the various daughter companies has been responsible for the research and development work. Apart from the early warning radar network, all the ground control and handling equipment has also been developed by English Electric.

From the outset the system has been designed for efficient and reliable operation in the hands of Service personnel under a wide range of operational conditions. Assembly and test of component parts can be done in the minimum of time, while loading, setting up, final test and firing are straight-forward. Components are "packaged" and readily accessible so that maintenance by replacement becomes a relatively simple operation. An efficient defence can, therefore, be obtained with the minimum of Service manpower. Experience has shown that the English Electric guided weapon system is capable of very rapid assimilation into the Services without expensive training programmes.

The missile itself is launched from the ground and has a two-stage propulsion system consisting of "boost" rockets, and a sustainer motor. While in flight the missile is steered to its target by control fins which receive their instructions from the guidance unit.

The system design enables the ground equipment to be reduced to a minimum. It consists only of the necessary assembly and test facilities, and launchers with remote control.

Films showing, in slow motion, some of the early development work that has led to the production of the English Electric guided missile have recently been shown to the Press and are to be released by the Central Office of Information. The films—which were part of the research records and are not specially "produced" for exhibition purposes—show the initial tests on small-scale rockets; development testing of the rocket motors; recovery tests; flight development of the rocket motors; and development of the guidance system, feeding in severe programmed manoeuvres to prove the robustness of the control system and components. Not shown in the films are the rigorous simulated flight tests on components and complete weapons carried out in the environmental test laboratory prior to the test firings. Such tests include drop tests (Fig. 2) to reproduce the accelerations and shock of the boost phase; vibration tests, both mechanical and acoustic; centrifuge tests to simulate lateral accelerations; and climatic tests in a chamber capable of simulating a wide range of pressure, temperature (− 70 deg. C. to + 80 deg. C.), and humidity.

ATOMIC REVIEW

On Approval

BRITAIN may be said to have a vested interest in an American reactor which has recently generated power for the first time. Early this year, Alco Products Incorporated, who built the Army Package Power Reactor (APPR), signed an agreement with a British company, Humphreys and Glasgow, Limited, whereby small power reactors based on this design would be made and marketed in this country. Last week in Atomic Review reference was made to a statement announcing that, owing to lower manufacturing costs in Europe, the estimated cost of power from a 10 MW APPR-type plant would be about 1*d.* to 1½*d.* a kilowatt-hour and not 1½*d.* to 2*d.* as originally stated. The APPR reactor has been previously discussed in Atomic Review on July 6, December 7, 1956, and February 8 this year. The advantage for Britain of an agreement of this kind is self evident. Once trial runs of APPR are completed, the British company will be in a position to assist in building, possibly for export, plants based on a tested prototype; in a sense we have the reactor on approval. The following notes are on APPR, paying special attention to control-rod drives and fuel-rod fabrication.

APPR

The Army Package Power Reactor is a 2,035 kW pressurised-water nuclear electrical generating plant built at Fort Belvoir, Virginia, by Alco Products, under contract to the United States Atomic Energy Commission for the United States Army. The net electrical output of the plant, 1,855 kW, will be utilised to supplement the Fort Belvoir power distribution system. Plant auxiliaries require 180 kW. The original design study by the Oak Ridge National Laboratory was for a reactor to meet the needs of remote military bases. Certain design requirements were modified to adapt the APPR to permanent construction in a populated area of the United States. Alco's contract to build the APPR was the first United States Government fixed-price contract for a nuclear power plant. It was awarded on December 10, 1954, and ground was broken on October 5, 1955. Stone and Webster Engineering Corporation were the engineer-constructors for Alco.

Primary System

In general, operation of the plant can be divided into two systems—primary and secondary as indicated in Fig. 1. The main components of the APPR primary system are: the reactor vessel and core, control rods and drives, two coolant circulating pumps, piping, the steam generator, a pressuriser, water purification equipment, and shielding. Housed in the reactor core are 38 fuel elements, containing enriched uranium, together with 7 control rods—all in a grid structure of a basic 7 by 7 design with the corners missing as may be seen from Fig. 2. Cooling water enters the reactor vessel at 431 deg. F. under a pressure of 1,200 lb.per sq. in. to prevent boiling. While circulating upward between the fuel plates at 4,000 gal. per minute, it is heated to 450 deg. F. before passing to the steam generator. At the steam generator, heat from the high-pressure primary water is transferred to the water in the secondary system, thus producing the steam used to drive the turbine. The cycle is completed by using special Westinghouse canned-rotor pumps to return the cooled primary water to the reactor. The two pumps are constructed primarily of 304L stainless steel and are similar to pumps used in the submarine Nautilus.

Secondary System

The secondary system of the APPR is composed essentially of the secondary side of the steam generator, the turbine-generator set, surface condenser and auxiliaries, feedwater heater, evaporator, pumps and storage tanks. Since no primary water is circulated in the system, no shielding is required and the entire system, except the steam generator, is outside the vapour container. In this system, steam is produced in the steam generator at a rate of 34,070 lb. per hour under pressure of 200 lb. per sq. in. at 407 deg. F. The steam, which has 25 deg. F. superheat, passes through the turbine to a surface de-aerating condenser and back to the steam generator through a feedwater heater. Feedwater for the steam generator is obtained from a condenser hot well and circulated by the combination condensate hot-well and boiler-feed pump through a closed-type feedwater heater. In the feedwater heater the temperature of the water is raised to 250 deg. F. by steam bled from the turbine at about 35 lb. per sq. in.

Reactor Core and Vessel

The reactor core consists of 38 fuel rods and seven control-rod assemblies fabricated by the Oak Ridge National Laboratory. The core and its supporting structure are housed in the stainless steel clad reactor vessel built by Alco, as illustrated in Fig. 3. The vessel is of 47¼ in. internal diameter and 162 in. overall length, and is clad with 0·125 in. of stainless steel on all surfaces in contact with primary water. The fully enriched uranium dioxide fuel is incorporated in flat plate type elements. Each fuel assembly consists of 18 composite fuel plates brazed into a pair of 304L stainless-steel side plates 27 in. long, 2·863 in. wide and 0·050 in. thick but spaced 0·133 in. apart to permit cooling-water access. The outside plates are 27 in. long, and the 16 internal plates are 23 in. long. Each assembly has on both ends a 304L stainless-steel grid adapter, or end box, attached by fusion welding. A pin is fitted to the bottom adapter and a spring to the top adapter to assist in locating the elements in the reactor

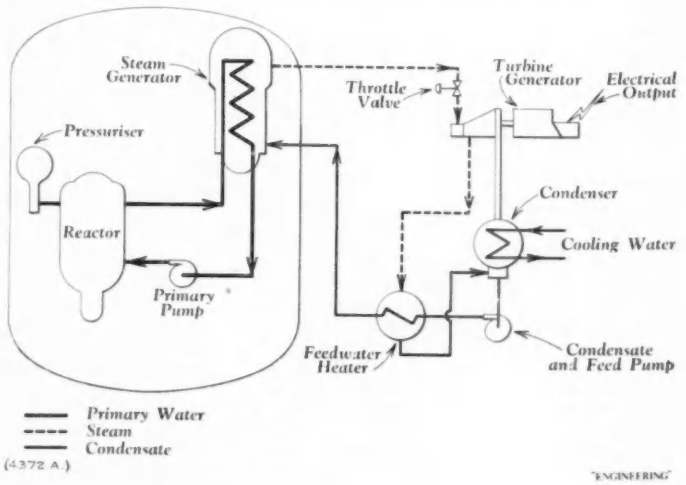


Fig. 1 Simplified flow diagram for Army Package Power Reactor (APPR), showing primary and secondary systems. Small power reactors based on this design are to be built and marketed by a British company.

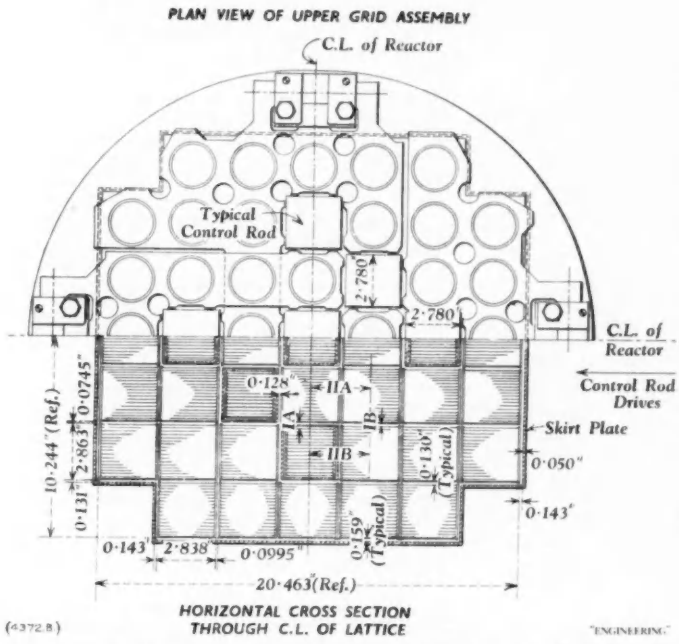


Fig. 2 The APPR core comprises 38 fuel rods and 7 control rod assemblies. Flat plates containing enriched uranium dioxide serve as fuel.

grid plates. The control rods consist of two sections: a fuel section, and an absorber section. Control-rod fuel plates are fabricated in the same manner as the stationary fuel plates, but are 23 in. long, 2·56 in. wide, and 0·03 in. thick. The absorber section is boron enriched in the isotope boron 10.

Steam Generator

The Alco-built steam generator (see sketch in Fig. 4) has a U-shaped tube bundle with 326 tubes each $\frac{3}{4}$ in. outside diameter by 0·062 in. wall, with a total effective heating surface of 836 sq. ft. Inside the same shell, separated from the generating section by a baffle plate, is the superheater section, with 194 sq. ft. of heating surface. Hence, the total heating surface of the generator is 1,030 sq. ft. The steam generator receives slightly radioactive water at 450 deg. F. from the primary system, while secondary water at 250 deg. F. enters the shell side about halfway up the steam-generating section at a full-load rate of 34,270 lb. per hour. The secondary water is converted into steam by contact with the tube bundle, which contains the heated primary water. This secondary-system steam is used to drive the turbine downstream in the secondary side of the plant. Type 304L stainless is used as the basic corrosion-resistant material in the steam generator. In addition, all piping (provided by the Tube-Turn Company) in the primary system is of solid stainless steel, of $\frac{3}{4}$ in. wall thickness and $12\frac{3}{4}$ in. outside diameter. The 1,200 lb. per sq. in. operating level of the primary system is maintained by two immersion heaters housed in a stainless-clad pressuriser. The pressuriser, which is 45 in. inside diameter and mounted on a cylinder 16 in. inside diameter by 54 in. long, contains sufficient steam and liquid to absorb fluctuations of primary liquid volume without excessive pressure changes. Water in the primary system is thoroughly purified to protect against corrosion. The primary system contains about 1,300 gallons of water which is circulated at a rate of about 4,000 gallons per minute. This water is maintained at a total solids concentration of not more than 2 parts per million. Demineralisers have been supplied by the General Ionics Corporation.

Shielding

The primary shield is a 156 in. diameter steel tank filled with water and containing eight concentric steel cylinders, as shown in Fig. 3. Each cylinder is 2 in. thick and the cylinders are separated by an inch-thick layer of water. The innermost cylinder also functions as the inner wall of the tank and as a support for the pressure vessel. An iron-water shield was selected because it weighs less, is smaller than an equivalent concrete shield, and permits faster fabrication on the site.

The secondary shield —5 ft. of concrete—was designed so that the dose rate will be less than 1·5 milliroentgens per hour at any point outside the vapour container at building level. Two feet of the secondary-shield concrete are inside the vapour container wall, with an additional 3 ft. on the outside of the container shell from ground level to a height equal to that of the control-room roof.

Vapour Container

The vapour container, which houses the primary system and the steam generator, is a combination steel and concrete structure 32 ft. inside diameter and 64 ft. in height. It was fabricated by the Bethlehem Steel Corporation from $\frac{7}{8}$ in. thick steel ring segments, and has both spherical ends and cylindrical section lined with 2 ft. of reinforced concrete. The inner surface of the 2 ft. thick inside concrete shield is lined with a light-steel plate shell which prevents contamination of the concrete liner and facilitates cleaning in the event of an accident.

Fuel Element Fabrication

The design of the fuel elements, which are briefly described in the section on the reactor core, is virtually unchanged from that originally proposed by the Oak Ridge National Laboratory. O.R.N.L. selected type 304L stainless steel as the wrought cladding, with 0·07 per cent. maximum carbon 304B stainless for the fuel-core matrix. They chose a dense uranium dioxide, in the size fraction of 44 to 88 microns, as the fuel material, and boron carbide as the burnable poison to be mixed intimately with the fuel oxide. The fuel core of the composite plate is prepared by adding 28·62 gm. of tungsten oxide (WO_2), 0·188 gm. of boron carbide (B_4C) and 99·80 gm. of stainless-steel powders. These materials are inserted in a small glass container, and a number of these containers are placed together in an oblique blender. After blending, the mixture is inserted in a die and pressed under 33 tons per sq. in. pressure to form the fuel core for the composite plate. When a number of cores have been accumulated, a batch is sintered in a hydrogen atmosphere at 2,150 deg. F. Each core is again placed in the die and coined in final size. Advantages of individual preparation, as against the possibly more economical batch blending, are accurate accounting of the uranium and boron and excellent homogeneity.

Once formed, the coined fuel cores are inserted in blanked frame plates; covers are attached to each side of the frame; and the plates fabricated into composite fuel plates. They are preheated in a hydrogen muffle at 2,100 deg. F. and rolled to a 91 per cent. reduction in thickness. During rolling, the stainless cladding is metallurgically bonded to the stainless-steel core material. The clad fuel is then reduced to its final dimensions—22 in. long, 2·5 in. wide and 0·020 in. thick—by cold rolling. After locating the fuel core by fluoroscopy, the plate is marked, sheared, and machined to a width of 2·776 in., thus allowing for an inactive steel protective edge along the length of the core.

Once annealed, the plates are assembled into a fuel array in a stainless-steel fixture designed to confine the fuel unit during assembling and brazing. After each plate is separately positioned, a thin layer of powdered Coast Metals "NP" braze metal is applied dry at the joint between the fuel and side plates and is fixed in position with "Nicrobraz Cement." A thin stripe of "Colmoney Green Stopoff" is added alongside to prevent lateral flow of braze metal on to the cladding above the fuel section of the plate. Combs are attached to each end of the unit to help maintain spacings between plates. The assembled fuel unit is now brazed in a protective hydrogen atmosphere, slowly and uniformly heated to 2,066 deg. F., and then furnace cooled. Following this, the unit is thoroughly cleaned in hot water. Then all critical dimensions, including spacings between plates, are measured, thus maintaining tight specifications requiring no additional machining. In fact, though specifications permit a 10 per cent. deviation of the nominal plate spacings, approximately 95 per cent. of the units brazed were held within 5 per cent. Final steps in completing the fuel assembly are Heliarc welding of end adapters to the fuel unit, machining the end

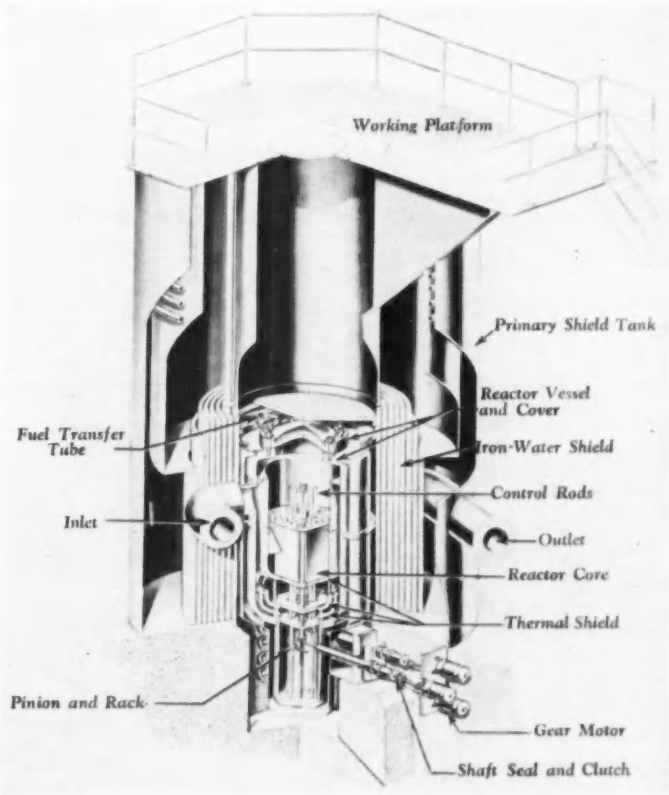


Fig. 3 Isometric sketch of the APPR reactor vessel, core and control-rod structure. Five control rods are shown but the reactor has in addition two safety rods normally in the fully withdrawn position.

adapters, and attaching the pin and spring. After thorough degreasing, the fuel element is ready for shipment. Fuel elements for the APPR are designed for 18 months operation at 10 MW and will probably be returned to a Government facility for recovery of uranium 235.

Core Support Mounting

The core-support mounting structure is bolted, with proper provision for differential expansion, to brackets on the upper vessel wall. The inner thermal shield is dual-purpose—it also forms a barrier to direct the flow of incoming water to the bottom of the core. The vessel supports are very near the level of the incoming and outgoing nozzles, which are in line with each other. This minimises the relative thermal expansion between these points, the only parts of the vessel rigidly fastened to external components. Control-rod drive mechanisms are protected from neutron damage and gamma radiation by a water box and 6 in. of steel around the drive-penetration tubes.

Control Rods and Drives

The reactivity of the reactor is lowered when the control rods are inserted in the reactor core. The seven control rods in the loading are identical; each is constructed in two segments. The upper segment, containing the boron 10 isotope in a matrix clad with stainless steel, resides in a lattice when the rod rests in the shock absorbers. The lower segment, containing a fuel element with 16 fuel plates, is raised into the lattice when the control rod is in the upper position. The plant is normally operated by five of the rods, with the remaining two raised.

The control rod drives are installed at the bottom of the reactor, permitting removal of the pressure-vessel cover and spent-fuel elements without removing the rod drives. The drive mechanism is illustrated in Fig. 5, showing left, the section inside, and right, the section outside the reactor. The pressure vessel includes an extension to accommodate control-rod racks. Individual tubes penetrate the extension at right angles, and a mounting flange supports the tubes 41 in. from the centre-line of the vessel. The seals and drive mechanisms are bolted to the mounting flange. The rods are motor driven, but in the event of an incident, emergency insertion of the control rods is effected by gravity Rod travel under motor control is at a rate of 3 in. per minute. The drive train consists of

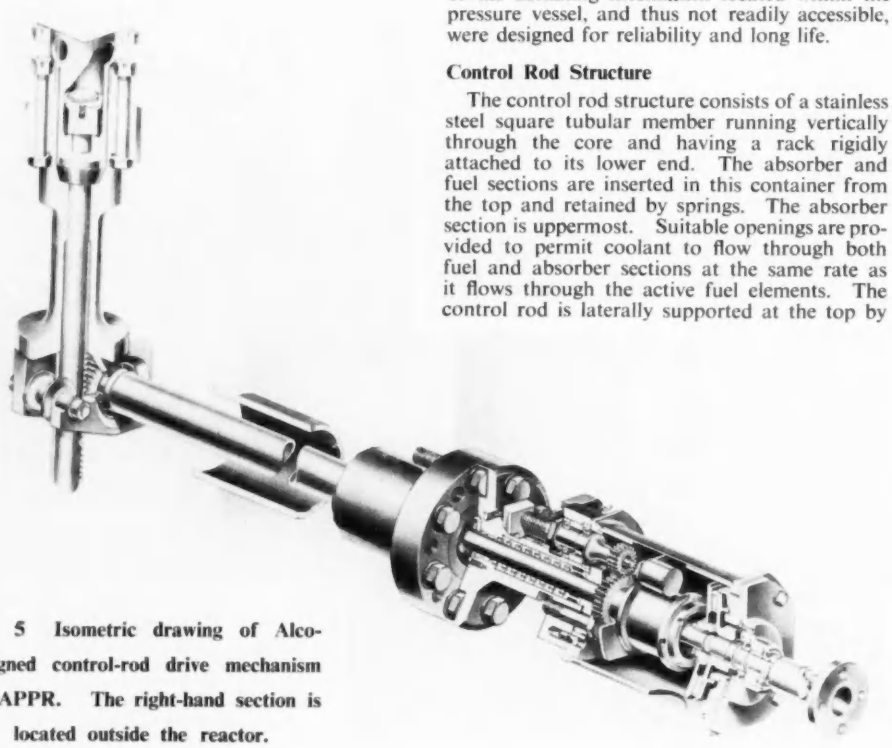


Fig. 5 Isometric drawing of Alco-designed control-rod drive mechanism for APPR. The right-hand section is located outside the reactor.

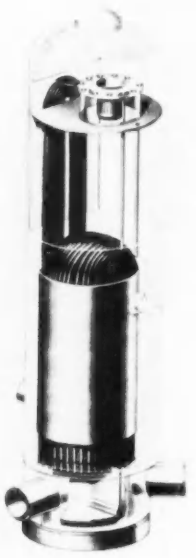


Fig. 4 The steam generator for the APPR plant comprises a U-shaped tube bundle containing 326 tubes, together with a superheater section giving a total heating surface of 1,030 sq. ft.

a rack attached to the bottom of each control rod, meshing with a pinion. A drive shaft fitted to each pinion extends outward through enclosing tubes, connecting through a Warner electric clutch to a motor and a reduction gear drive. A metallic sealing unit prevents leakage where the pinion shaft penetrates the pressure containing wall. This seal consists of a series of floating rings surrounding the shaft. The rings provide a close-clearance annular leakage path from the pressure volume to the outside. There is a small controlled amount of leakage as a result of this close clearance. Make-up water for the primary system is introduced at the high pressure end of the seal. Leakage is largely confined to uncontaminated water, which is processed along with primary system blow-down.

Control Rod Actuating Mechanism

The actuating mechanism comprises two major assemblies for each control rod. The rack and pinion assembly, including associated bearings, operates in the primary-system water and is inside the pressure vessel. The second assembly includes a three-phase, 60 cycle driving motor with integral brake and reduction gear boss, emergency shut-down clutch, rod position indicator and limit switches—all located outside the pressure vessel, but within the vapour container. They are of conventional design, and are conventionally lubricated, inspected and maintained. The other components of the actuating mechanism located within the pressure vessel, and thus not readily accessible, were designed for reliability and long life.

Control Rod Structure

The control rod structure consists of a stainless steel square tubular member running vertically through the core and having a rack rigidly attached to its lower end. The absorber and fuel sections are inserted in this container from the top and retained by springs. The absorber section is uppermost. Suitable openings are provided to permit coolant to flow through both fuel and absorber sections at the same rate as it flows through the active fuel elements. The control rod is laterally supported at the top by slide surfaces and at the rack end by the pinion and back-up roller. No intermediate support is used. External clearances except at the two support points are great enough to prevent danger of binding due to thermal distortion, foreign matter, or other conditions. Emergency insertion of the control rods is performed by de-energising the electric emergency clutch. This unit has a torque rating approximately three times that required to operate the rods. Release time of the clutch is 0·053 seconds maximum. Effective weight of the control rod assembly is approximately 61 lb. (including flotation effect with the reactor cold). Inertia mass of the rod assembly is 2·18 slugs, and inertia of all connected rotating parts referred to the rod is 0·145 slugs.

Conferences

In connection with the international atomic exhibition " Het Atoom " to be held in Amsterdam from July 1 to September 16 and referred to in Atomic Review on February 1, a number of scientific conferences will be taking place. They are as follow: (1) a conference on radioactive isotopes sponsored by the Organisation for European Economic Co-operation (June 24 to 29); it succeeds the conference recently held in Paris; (2) three national conferences on industrial management (July 10 and 31, and September 4); (3) the national conference of the Royal Netherlands Chemical Society (July 15, 16 and 17); and (4) the annual meeting of the European Atomic Energy Society under the chairmanship of Sir John Cockcroft (September). Details of Het Atoom may be obtained from Galitzine and Partners Limited, 17 Victoria-street, London, S.W.1.

An Inter-American Symposium on the Peaceful Applications of Nuclear Energy will be held from May 13 to 17, 1957, at Brookhaven National Laboratory. The symposium agenda is designed to stimulate efforts among the American Republics to develop and utilise the beneficial applications of nuclear energy. The symposium is being conducted by the Brookhaven National Laboratory and jointly sponsored by the Atomic Energy Commission, the Department of State and the International Cooperation Administration. The primary purpose of this bi-lingual symposium will be to explore present and future uses of atomic energy in the Americas.

The next nuclear physics conference of the Physical Society will be held on July 17 and 18, 1957, in the Physical Laboratories of Manchester University. It will be organised by Professor S. Devons, F.R.S., and will probably include five sessions dealing with: static nuclear properties, nuclear dynamics, nuclear forces, meson physics and beta decay. Those wishing to contribute should write to Dr. J. M. Calvert, The Physical Laboratories, The University, Manchester 13. The Society will also hold a conference on materials for nuclear engineering on July 11 and 12 at Associated Electrical Industries, Limited, Aldermaston, Berkshire.

A conference on plasma and atomic physics is to be held at the Atomic Energy Research Establishment on October 3 and 4, 1957, and the topics to be covered are atomic collisions, ionospheric physics and plasma physics. Intending contributors should send names and titles of talks to Dr. P. A. Davenport of the General Physics Division, A.E.R.E., Harwell, Berkshire.

A conference on the peaceful uses of atomic energy is being held in Tokyo from May 13 to 17 and is sponsored by the Atomic Industrial Forums of the United States and Japan. Among the speakers will be Mr. Richard S. Morse, President of the National Research Corporation, who will discuss " The Role of Small Business in the Atomic Energy Industry."

★ ★ ★

Mancuna Engineering Limited state that their two-stage D.450 dust collector has a collection efficiency of 99 per cent. and not 90 per cent. as reported on page 510 of our issue of April 19.

THE BRITISH INDUSTRIES FAIR

CASTLE BROMWICH ON ITS OWN

For some years past the Castle Bromwich, Birmingham, section of the British Industries Fair has been concerned mainly with the products of engineering and the hardware trades. This year, with the B.I.F. concentrated at Castle Bromwich and the London sections discontinued, the general pattern at Castle Bromwich remains the same as before. A considerable amount of space is devoted to hardware, much of it principally of interest to individual purchasers of domestic equipment, but the requirements of the building trades are also covered in this part of the exhibition. In the electrical section again, there is much of domestic interest, though control gear and motors are also on show.

MATERIALS HANDLING

Equipment on show for conveying, transporting, screening and packing materials ranges from fork-lift trucks to automatic weighers and packers. Conveyancer Fork Trucks, Limited, Liverpool-road, Warrington, have, in addition to their well-known range of orthodox trucks, load-clamping types, including one which can be used for handling cartons, crates and similar objects without pallets. A new fork-lift truck introduced by this Company is the flameproof model, with electrical equipment to comply in all respects with the Ministry of Power Test Memorandum No. 11 and Safety in Mines Research Establishment Report No. 122. The truck has a capacity of 4,000 lb. at 20 in. load centres, and a 4,500 lb. version will also be available. Ransomes, Sims and Jefferies, Limited, Orwell Works, Ipswich, also have a new fork-lift truck, with a capacity of 3,000 lb. at 20 in. load centres. In the heavy fork-lift field, Shelvoke and Drewry, Limited, Letchworth, have a new version of their "Freightlifter," which has a capacity of 18,000 lb. at 33 in. load centres. This is a Diesel-engined machine, with a duplicated control cab, one in the normal position with full visibility of the lifting forks, and the other at the opposite end for use when the truck is travelling on public roads.

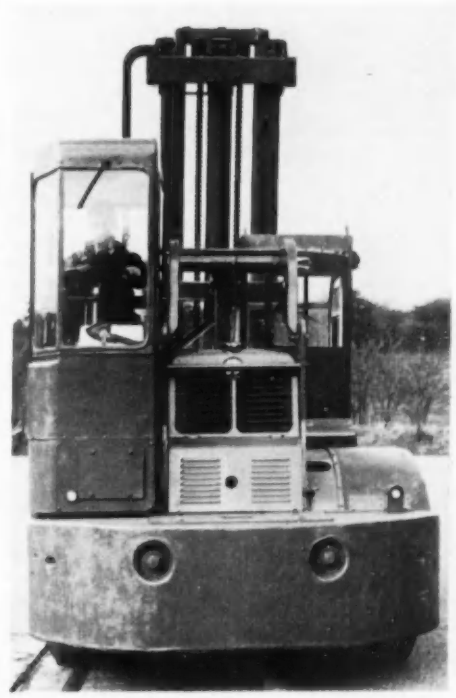
The range of materials handling equipment made by Fisher and Ludlow, Limited, Bordesley Works, Birmingham, 12, covers all types of conveyors and storage equipment, together with pallets for use with fork-lift trucks. A new type of pallet exhibited consists of a transportable stand, in the top section of which is a box pallet of components to be machined, a hopper with a return chute, and a receiving box pallet in the base of the stand. As the top pallet is placed in position by a standard fork-lift truck, a sliding door opens automatically to release a gravity feed of components into the hopper. The machine operator takes a component from the hopper, passes it through the required machining operation, and then places it in the return chute, leading to the receiving pallet.

A new type of conveyor, power-pushed, with loose pallets, is shown by Transmission Accessories, Limited, Leighton Buzzard. This conveyor, which is built from standardised components, and can be re-routed after initial installation if required, is of simple design; it is intended to compete with roller conveyors.

CONTROL OF FLUIDS

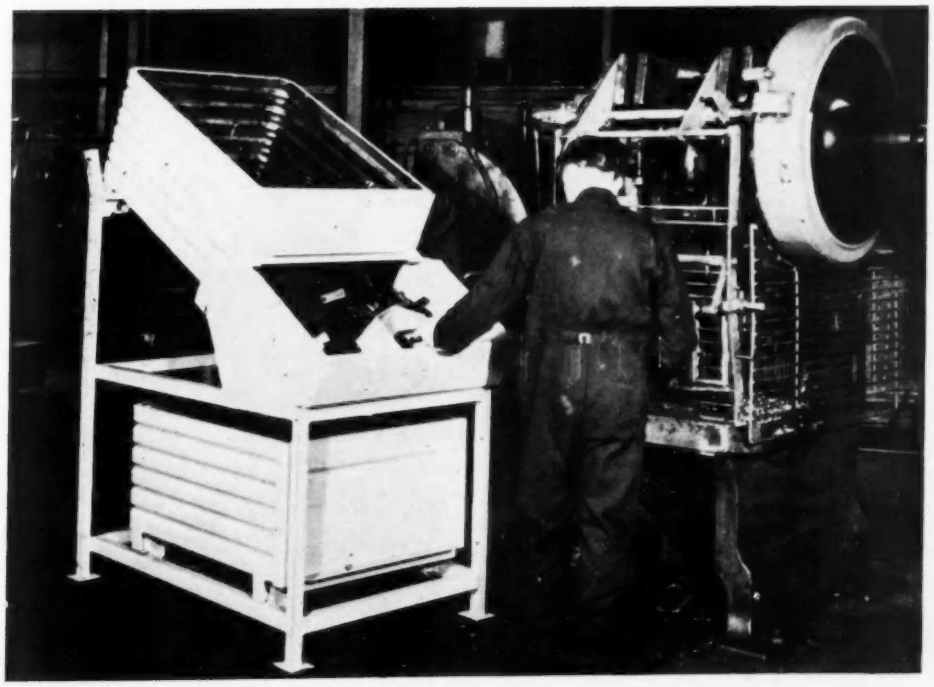
Valves for the control of compressed air or of liquids are exhibited by several manufacturers, and range from simple hand-operated models to power types with various forms of automatic control. Some of the exhibits are modifications of well-known types. The diaphragm valve made by the Saunders Valve Company, Limited, Cwmbran, for example, is now available in a high-pressure closing, power operated version, in a size range from 1½ in. to 5 in., and with emergency handwheel closure if required. Hydraulic valves, with hand or compressed air control, and suitable for pressures up to 10,000 lb. per sq. in. are shown by George Ellison, Limited, Perry Barr, Birmingham, 22B, together with examples of their range of electrical switchgear.

Air compressors, which are exhibited by several makers are mostly of small capacity, as has been the case at Castle Bromwich for some years, but the size range of machines on show has been increased by the larger Hydrovane compressors introduced by Whittaker Hall and Company (1929), Limited, Radcliffe, Manchester. These compressors are now available to deliver up to 600 cub. ft. of free air per minute, and complete the Hydrovane series made in the smaller sizes by Alfred Bullows and Sons, Limited, Walsall, and as portable machines by the Hymatic Engineering Company, Limited, Redditch, and the Burtonwood Engineering Company, Limited, Warrington.



For running on public roads this Shelvoke and Drewry fork-lift truck has two control cabs.

A new machine in the small output class is the single-stage portable petrol-engine driven compressor giving 4½ cub. ft. of free air per minute, made by H.E.C. Compressors and Engines, Limited, Stechford, Birmingham, 33. This machine is fitted with a power take-off from the 1 h.p. two-stroke engine which drives it.



A hopper feeds components to an operator from a pallet, and he transfers them after pressing or machining to a second pallet on the Fisher and Ludlow automatic feed system.

FOUNDRY EQUIPMENT AND FURNACES

A feature of this year's B.I.F. is the increased space devoted to equipment, including melting furnaces, for ferrous and non-ferrous foundries. Birlec Limited, Tyburn-road, Erdington, Birmingham, 24, have on show an example of their Ajaxomatic furnace for feeding molten aluminium and zinc alloys to die-casting machines. This furnace, which is designed for holding, not melting, has not previously been shown in this country. It is of the induction type, with an iron core, and is rated at 20 kW. The amount of metal delivered can be adjusted between ½ lb. and 10 lb. per shot, the control being by push button; alternatively, the operation can be coupled into a die-casting machine cycle.

Keith Blackman, Limited, Mill Mead-road, London, N.17, have a scale model of the Cupodel hot-blast cupola, together with various fans and other equipment applicable to foundry work, and Foundry Mechanisations (Baillot), Limited, Bletchley, show a range of foundry equipment including sand preparation and distribution plants, mould conveyors, and a cupola charging system.

The range of furnaces shown by Lees Hall and Sons, Limited, Lewes-road, Newhaven, Sussex, includes their new furnace, designed for melting cast iron with fuel oil. It is made in sizes ranging from ½ to 5 tons capacity, and apart from its obvious application in parts of the world where coke is scarce and oil plentiful, the manufacturers claim that it will produce a better quality iron owing to freedom from the contamination troubles experienced with coke.

METAL PRESSING AND FORMING

Equipment such as power and folding presses, bending rolls, shears, and other sheet and plate metal working machinery has for many years

been shown at the B.I.F., and this year is no exception. The Scottish Machine Tool Corporation, Limited, 58 Victoria-street, London, S.W.1, have a range of machines on exhibition including a 100 ton power press, plate-bending rolls, and a universal folding and bending machine. This latter machine is capable of folding or bending mild-steel plate up to 8 ft. long by ¼ in. thick. Similar machines are also shown by the Bronx Engineering Company, Limited, Lye, near Stourbridge, and this range includes a light folding machine for hand operation. It is fitted with two hand levers, one for direct operation of the upper beam when working light-gauge material, while the other operates through a ratchet for the heavier gauges.

Power press equipment, including press guards, is similar to that which has been shown at the B.I.F. before, but there are also new items on exhibition. Press Guards, Limited, 372/8 Farm-street, Birmingham, 19, have an interlocking guard for press brakes, new guards for power presses, and a press sequence controller which provides electrical impulses at pre-determined points during a press stroke. These impulses can be used to open or close circuits and so control subsidiary operations during pressing. The press crankshaft rotation of 360 deg. is divided into 72 points of impulse, spaced at 5 deg. intervals, and up to 8 of these points can be selected to operate in each cycle.

MATERIALS

Many materials used in engineering are shown at the B.I.F., including not only the well-known metals such as aluminium alloys and copper alloys, but also some of the metals which, as engineering materials are rare, such as zirconium, and some which are becoming more widely known, such as titanium. All these metals are exhibited by Imperial Chemical Industries, Limited, Millbank, London, S.W.1, who also show some of their plastics products. Non-metallic materials are featured by the Dunlop Rubber Company, Limited, Erdington, Birmingham, 24, with engineering components made in a new synthetic rubber, and by Tufnol Limited, Perry Barr, Birmingham, 22B.

PRIME MOVERS

For many years the prime movers shown at the B.I.F. have been of the light and medium types, and the present exhibition also provides examples of small petrol and Diesel engines. Belliss and Morcom, Limited, Ledsam-street, Birmingham, 16, however, are showing a larger engine than has been seen at the B.I.F. for some time. It is a pressure-charged six-cylinder vertical engine running on the four-stroke cycle, and developing 1,140 b.h.p. continuously at 357 r.p.m. for a fuel consumption of 0·36 lb. per b.h.p. per hour. The engine has a bore and stroke of 15½ in. and 20 in. respectively. Pressure charging is by a gas turbine, running on exhaust gases and driving a centrifugal blower. The engine is one of a series built as two to eight cylinder units with power ratings from 120 to 2,000 b.h.p. and speeds of up to 600 r.p.m. The same makers also show a small steam turbine designed for instructional purposes and mounted on a common bedplate with a Heenan and Froude dynamometer. The turbine is suitable for pressures up to 200 lb. per sq. in., temperatures up to 500 deg. F., and normal running speeds of between 4,000 and 8,000 r.p.m., with a maximum power output of 30 b.h.p.

Pre-determined quantities of molten aluminium or zinc alloy are delivered under push-button control by the Birlec Ajaxomatic holding furnace.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

BOURNEMOUTH
Annual General Meeting. Bournemouth Branch. Grand Hotel, Firvale-road, Bournemouth. Tues., May 14, 7.15 p.m.

Building Centre

LONDON
Films on "Tubes of all Trades," exhibited by Stewarts and Lloyds Ltd. Wed., May 15, 12.45 p.m.
Films on the construction of wharves and reservoirs, exhibited by Richard Costain Ltd. Wed., May 22, 12.45 p.m.

Chemical Engineering Group

LONDON
"Some New Chemical and Physical Aspects of Polyester Resin Technology," by L. H. Vaughan. Joint Meeting with the Plastics and Polymer Group. The Society of Chemical Industry, 14 Belgrave-square, S.W.1. Tues., May 14, 5.30 p.m.

Chemical Society

DURHAM
"Chemical Evolution," by Professor J. D. Bernal. Newcastle and Durham Branch. University Science Laboratories, South-road, Durham. Mon., May 13, 5.15 p.m.
EXETER
"Reduction by Metal-Ammonia Solutions," by Professor A. J. Birch. Exeter Branch. Washington Singer Laboratories, Prince of Wales-road, Exeter. Fri., May 17, 5 p.m.
GLASGOW
Centenary Lecture on "Structural Evidence Regarding the Solid Addition-Compounds of Ethers and Amines with Halogens and Other Molecules Acting as Electron Acceptors," by Professor Dr. O. Hassel. Glasgow Branch. Chemistry Department, The University, Glasgow. Tues., May 14, 4 p.m.

Illuminating Engineering Society

LONDON
Annual General Meeting, at 5.30 p.m. "Changing Tastes in Design," by Paul Reilly, at 6.30 p.m. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 14.
LIVERPOOL
Annual General Meeting. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., May 14, 6 p.m.

Incorporated Plant Engineers

MANCHESTER
"High-Pressure Hydraulic Pumps and Their Associated Control Valves," by A. M. Worswick. Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., May 14, 7.15 p.m.
ROCHESTER
"Safety and the Factories Act," by V. B. Jones. Kent Branch. King's Head Hotel, High-street, Rochester. Wed., May 15, 7 p.m.

Institution of Civil Engineers

LONDON
James Forrest Lecture on "Large Telescopes," by Dr. R. v.d. R. Woolley. Tues., May 14, 5.30 p.m.*
Discussion on the "Report on the Development of Hydro-Electric Power in the Soviet Union." Joint Meeting with the Institutions of Electrical and Mechanical Engineers. Mon., May 20, 5.30 p.m.*
"Brick and Masonry Arch Bridges: an Investigation," by C. S. Chettoe and William Henderson. Structural and Building Division. Tues., May 21, 5.30 p.m.*
BRISTOL
Annual General Meeting. South Western Association. New Engineering School, University-walk, Bristol, 8. Thurs., May 16, 6 p.m.
NEWCASTLE-UPON-TYNE
Association Annual General Meeting. Northern Counties Association. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Tues., May 14, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "A Survey of Transistor Circuit Techniques." Radio and Telecommunication Section. Wed., May 15, 5.30 p.m.*
"Voltage Performance of Series Capacitors in Transmission and Distribution Lines," by J. M. Magowan (to be read by L. L. Langton). Supply Section. Wed., May 22, 5.30 p.m.*
Annual General Meeting and Film Evening. London Graduate and Student Section. Mon., May 20, 6.30 p.m.*
Institution's Annual General Meeting (Corporate Members), at 5.30 p.m.* "General Applications of Digital Computers," by Dr. A. D. Booth, at 6.30 p.m. Thurs., May 23.
BELFAST
Annual General Meeting. Northern Ireland Centre. Engineering Department, Queen's University, Belfast. Tues., May 14, 6.30 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
Annual General Meeting. North East Branch. Crown Hotel, Clayton-street, Newcastle-upon-Tyne. Fri., May 24, 6.15 p.m. (To be followed by the annual dinner at 7.30 p.m.)

Institution of Mechanical Engineers

LONDON
Annual General Meeting. "Modern Marine Propulsion," by A. R. Hopwood and R. S. Saunders. London Graduates' Section. Tues., May 14, 6.30 p.m.*
"Diesel Engine Lubricants: Their Selection and Utilisation, with Particular Reference to Oil Alkalinity," by A. Dyson, L. J. Richards and K. R. Williams. Meeting in conjunction with the Lubrication and Internal Combustion Engine Groups. Fri., May 17, 6 p.m.*
COVENTRY
Repetition of James Clayton Lecture on "Mechanical Breathing Machines," by Captain G. T. Smith-Clarke. Midland Branch. St. Mary's Hall, Coventry. Thurs., May 16, 6.30 p.m.

Institution of Mining and Metallurgy

LONDON
Annual General Meeting, at 4 p.m., open only to corporate and non-corporate members of the Institution. Induction of G. Keith Allen as President and other business, at 5.15 p.m. Geological Society's apartments, Burlington House, Piccadilly, W.1. Thurs., May 16. (Tea at 4.30 p.m.)

Institution of Production Engineers

WOLVERHAMPTON
"Gas Turbines: Basic Principles and Production Difficulties," by C. E. Wurr. Wolverhampton Graduate Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., May 15, 7.30 p.m.

Royal Aeronautical Society

LONDON
"Reinforced Plastics for Primary Aircraft Structures," by W. A. Baker. Tues., May 14, 7 p.m.
"Guided Weapon Research and Development," by W. H. Stevens. Graduates' and Students' Section. Wed., May 15, 7.30 p.m.

Royal Institution

LONDON
"Solar Energy: A Challenge to the Future," by Dr. Harold Heywood. Fri., May 24, 9 p.m.
"How Glue Sticks," by Dr. N. A. de Bruyne. Fri., May 31, 9 p.m.

Royal Meteorological Society

LONDON
Discussion on "Analysis of Geophysical Time Series," opened by J. M. Craddock, H. Charnock and Dr. S. Rushton. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., May 15, 5.15 p.m.*

Royal Microscopical Society

LONDON
"Studies on the Mechanism of Muscular Contraction," by Dr. E. H. Huxley. Wed., May 15, 5.30 p.m.

Royal Society of Arts

LONDON
Trueman Wood Lecture on "Science in Archaeology," by Sir Mortimer Wheeler. Wed., May 15, 2.30 p.m.

Society of Industrial Radiology

LONDON
"Investment Castings and Their Inspection," by A. Tomkinson. British Institute of Radiology, 32 Welbeck-street, W.1. Fri., May 24, 7 p.m.

Society of Instrument Technology

MANCHESTER
Annual General Meeting. "Industrial Application of Radio Isotopes," by H. A. Tapsfield. Manchester Section. College of Technology, Manchester. Tues., May 14, 7.30 p.m.
NEWCASTLE-UPON-TYNE
Annual General Meeting. Newcastle Section. King's College, Newcastle-upon-Tyne. Wed., May 15 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHitehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHitehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Microscopical Society, Tavistock House South, Tavistock-square, London, W.C.1. (EUSton 2048.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Society of Industrial Radiology, 2 Tomswood-terrace, Barking-side, Essex. (HAInault 5488.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)

In Parliament

INVESTMENT IN EMPIRE

A debate on the resources of the British Commonwealth and Empire took place in the House of Commons on Friday last. It was opened by Mr. J. A. Langford-Holt (Conservative), who moved a resolution calling upon the Government to consider, as a matter of urgency, and in consultation with other members of the Commonwealth, how best to achieve the capital and technical skill required for their economic and social progress.

He pointed out that the circumstances had altered. Until lately, it appeared that probably the greatest barrier to any form of increased provision from this country for the development of natural resources oversea was the immense defence burden which Britain was having to carry. The United Kingdom was the traditional source of external capital for Commonwealth investment and she had special responsibilities towards the colonies. These areas had immense natural resources but time was running out and, if Britain did not do something, some other country would. Britain could not complain, or be surprised, if what was called welcome dollar investment turned into a dollar empire, accompanied by the American way of life. The Americans would like to have an increasing stake in the Commonwealth and empire, and could hardly be blamed for taking an interest in it, financially and culturally.

Much money was raised from the people of this country in the form of Government loans of various kinds. Was there any good reason why there should not be an Empire and Colonial Development Loan?

NEED FOR COMMONWEALTH BANK

Seconding the motion, Sir Albert Braithwaite (Conservative) said that he thought it would be dangerous for Britain to enter the European Common Market until she was sure that she would be the purveyor of the bulk of the raw materials required on the Continent. In his view, some £300 million a year would be needed over the next ten years, on a long-term basis and with a low rate of interest. The Colonial Development Corporation should be expanded into an organisation with its own bank, which could raise its own loans from anywhere; these loans being guaranteed by the Commonwealth so that investors would have security.

A plea for a clearing house for co-ordinating information about the Commonwealth's resources was put forward by Mr. Emanuel Shinwell (Labour). The coming conference of Prime Ministers would be no different from its forerunners unless Members stimulated the Government, in the absence of proposals from other Commonwealth countries, to press forward with the development of resources of raw materials, manpower and technical ability. Unless the resources of the Commonwealth were developed and standards of living improved all the strategy which the Prime Ministers might discuss would be of no avail.

BRITAIN'S LINKS OVERSEA

Another Conservative speaker, Mr. Bernard Braine, considered that nearly all the links which bound the Commonwealth together were fast becoming weaker. Britain was losing her preponderant position in Commonwealth markets. Side by side with this state of affairs was the eagerness of the United States and Russia to take part in the development of the Commonwealth, the potentialities of which they well realised.

Replying to the debate, Mr. Nigel Birch, the Economic Secretary of the Treasury, said that public and private investment in the Commonwealth was now running at the rate of about £150 million a year. Consultations with Commonwealth countries on the establishment of an agency for the integration of development plans were not completed. It would be deceiving the House to suggest that the answers so far received were particularly favourable. These countries were highly independent in their views and it might well be that too much intervention by Britain would not be welcomed.

COLONIAL MINERAL DEVELOPMENTS

Some information regarding recent negotiations between certain colonial Governments and British and American firms for the development of local mineral deposits was given by Mr. Alan Lennox-Boyd, the Secretary of State for the Colonies, to Sir Leslie Plummer (Labour). He said that there had been no such negotiations for the extraction of radio-active minerals with the Government of Northern Rhodesia. No negotiations were taking place with companies about the extraction of oil from the Gambia. In Nyasaland, no negotiations were in progress with the Government.

British Titan Products Limited (British) and Columbia Southern Chemicals (United States) had been negotiating jointly with the Government of Sierra Leone for the extraction of rutile. Conoco Somal Limited (United States) and the Standard Vacuum Oil Company (United States) were negotiating with the Government of Somaliland for the grant of oil prospecting licences, and the terms on which oil mining leases would subsequently be granted.

None of these raw materials had so far been produced in commercial quantities and it was not yet possible to determine to what extent they would be used to develop the territories' own industrial potentialities. Because certain minerals were found in a particular territory, it did not necessarily follow that the economic interests of that territory were best served by developing local industries merely to make use of those substances on the spot. The areas might derive greater economic benefits by marketing all their resources in international trade.

Conference on Nile Waters

The two agreements now in force in regard to the control and use of the waters of the River Nile are between the British Government and Egypt only. Neither treaty, Mr. Selwyn Lloyd, the Secretary of State for Foreign Affairs, informed Mr. E. S. T. Johnson (Conservative) contained any provision fixing the date when it expired. Mr. Fenner Brockway (Labour) intervened to ask that an approach should be made to the Egyptian Government, in view of the fact that the development of not only the Sudan, but also of Uganda and Tanganyika, was being retarded by the existing situation. Mr. Lloyd answered that he agreed that " some sort " of technical conference of the countries concerned, including many more states or territories than just Great Britain and Egypt, should be held.

(Some of the problems involved in controlling the Nile waters are referred to in the memoir of Sir Murdoch MacDonald, on page 580.)

Safety Precautions at the Docks

Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour, told Mr. Arthur Skeffington (Labour) that he was not yet in a position to make a statement as to when new dock regulations would be introduced. Officers of the Ministry of Labour had had useful discussions with the Dock and Harbour Authorities Association and the British Transport Commission, but the practical problems involved were extremely complicated and further examination was necessary. It was clear, for example, that the provision of additional vertical ladders and hanging chains would not be the best way to secure safety.

Credit System Inquiry

The membership of the committee which is to inquire into the working of the monetary and credit system was announced by Mr. Peter Thorneycroft, the Chancellor of the Exchequer, in reply to questions by Members.

In addition to the chairman, Lord Radcliffe, who has been a Lord of Appeal in Ordinary since 1949, the committee will comprise eight members, four of whom are business men, two economists and two trade unionists. Among the names announced by Mr. Thorneycroft were those of Sir John Woods, G.C.B., a former permanent secretary to the Board of Trade, who is now a director of the English Electric Company, Limited; Sir Reginald Verdon Smith, chairman and joint managing director of the Bristol Aeroplane Company, Limited; and Mr. W. E. Jones, President of the National Union of Mineworkers, who was a regional labour director of the Ministry of Fuel and Power during the recent war.

Metric System for Screw Threads

Mr. Austen Albu (Labour) asked Sir David Eccles, the President of the Board of Trade, what steps his Ministry was taking to encourage British manufacturers to offer their goods with dimensions in metric terms, in view of the discussions now proceeding for the establishment of a European free trade area. He pointed out that in such an area, manufacturers in the United Kingdom would be selling to customers who would be operating the metric method of measurement, including the international screw thread system.

He was informed by Mr. F. J. Erroll, the Parliamentary Secretary to the Board of Trade, that every opportunity was taken to encourage manufacturers to offer goods which were suitable in all respects to their oversea customers. There was not any universally accepted international metric system of screw threads at present, and it was understood that threads in inch sizes were widely used in certain metric countries.

(A Letter to the Editor giving suggestions for the standardising of screw threads appeared in our issue of April 12, page 453.)

Steel Sheets for Motor Cars

In reply to a previous question by Mr. Austen Albu, Mr. Erroll said that the President of the Board of Trade had not had discussions with motor-car manufacturers about any shortages of steel sheets likely to arise later in the year. The availability of future supplies was a matter for discussion by the motor industry with the steel sheet producers and with the Iron and Steel Board.

Water Improvement Schemes

A request for information concerning the total amount of Government grants paid to rural district councils under the Rural Water Supplies and Sewerage Acts, 1944 to 1955, in respect of schemes approved since April 1, 1950, was addressed by Sir Robert Grimston (Conservative) to the Minister of Housing and Local Government. Mr. Henry Brooke said that the Government had agreed to pay grants amounting, in capital value, to just over £31 million in respect of schemes approved during the period from April 1, 1950, to March 31, 1957.

(A Letter to the Editor on " Water Economics," appears on page 584.)

More Sandwich Courses

A request was put forward by Mr. Ben Parkin (Labour) for information regarding the increases in the numbers of scientific and technical students taking sandwich courses, which would be required to achieve the Government's objective of doubling the country's output of scientific manpower. Sir Edward Boyle, Bt., the Parliamentary Secretary to the Ministry of Education, said that the Government's plans for increasing scientific manpower depended on the expansion of university facilities and of all types of courses in technical colleges. It could not be stated precisely to what extent sandwich courses, in particular, would be required to contribute, but it might well be by as much as five or six times their present output. Technical colleges were already making encouraging progress in consultation with industry, in the setting up of new courses. The necessary additional accommodation was being provided.

THE HUMAN ELEMENT

Trade Unions in the Free World

The recent somewhat sensitive comments of Mr. George Meaney to suggestions in this country that the International Confederation of Free Trade Unions was in mortal danger owing to a certain amount of boat-rocking from the United States affiliated organisations did little to dispel the impression or the correctness of the metaphor. Mr. Meaney is President of the American Federation of Labour and Congress of Industrial Organisations. It is clear that those he represents hold in about equal distrust international communism and old world imperialism which is often referred to as colonialism. Given two such antipathies and the determination to take a robust line in dealing with them and there is plenty of scope for jeopardising organised trade unionism in the free world.

The forceful tactics of the United States element, perfected in the rough and tumble of internal American management-labour relations, fit uneasily into the tactics of the T.U.C. with its devotion to gradualism or the varigated battle plans conceived on the Continent where, even in the free world, there is a certain amount of loyalty to Marxism and a preference for intellectual hair splitting rather than American hustle. The I.C.F.T.U. has done much good work. It is a difficult alliance to keep intact for the will to compromise is not always marked on all sides. But some of the happiest marriages are sometimes the least placid.

With or Without Strings

The Court of Inquiry on the engineering and shipbuilding wage dispute recommend either a 5 per cent. rise and freedom to place a new claim immediately or a 6½ per cent. rise contingent on the acceptance of employers' conditions. Of these the chief one was that no new claim should be made within 12 months of the agreement's signature. The A.E.U.'s reaction was reserved —only the Communists immediately raised their voices in favour of a 6½ per cent. rise without strings, but the full meaning of the choice will take some time to assess.

The Court made two important suggestions. One aims to secure more integration between the various factors at play in wage negotiations, through the setting up of a National Joint Council in each industry to carry out periodic wage reviews on the basis of changes in the cost of living, productivity and economic prospects, and to improve efficiency and productivity. The other is that the Government should set up an authoritative and impartial body "to examine and advise on the wider problems of wage policy in an inflationary setting."

Almost everyone studying the wages structure of the engineering industry would reach the conclusions that a national review is needed urgently. Yet to do this to some purpose clearly implies a national wages structure of some kind and a corresponding fall in the Union's influence. A major change of heart would be needed to make this possible. The suggestion for National Joint Councils is more likely to get Union support, but also more likely to be opposed by the employers.

Caution at Eastbourne

The annual conference of the Amalgamated Engineering Union held at Eastbourne spent its first week feeling its way out of the militancy generated by the conflict over wages. An attempt by a Communist member of the executive to commit the Union to a new wage claim prior to the settlement of the current one was decisively defeated. The matter will be debated in the light of the Court of Inquiry's findings published during the conference's first week.

This does not mean that the A.E.U. are against the pressing of wage claims. The new president, Mr. W. J. Carron, made it clear that in his view a "logically reasoned wage claim is an effect, not a cause of inflation." But this year claims are likely to be concerned with shorter hours, longer holidays with pay and increased compensation for working outside normal working hours rather than with a rise in wage rates. The long-standing demand for a reduction in the working week from 44 hours to 40 without loss of pay, and for a third week's annual holiday were re-iterated but with a greater sense of urgency. The mood of the Conference was well expressed by the Sheffield delegate who said "it is time we put teeth into" the claims.

The firm but moderate attitude of Mr. Carron, who is a Catholic and unlikely to be favourably disposed towards the extreme Left of the Union, has already influenced the conference on the side of caution. There is beginning to be a recognition of the nation's need for higher productivity and therefore for some degree of wage stability; also, that redundancy is not necessarily the employer's fault. The suggestion that a national wage fund should be set up to finance the movement of workers from job to job was a useful contribution to a major unsolved problem. All in all, the A.E.U. conference's first week suggested a wish to be conciliatory and a growing understanding that the workers and employers stand or fall together.

Finance and Fecklessness

Among the engineering unions now looking at the ravages of their finances after the recent strike, none have more cause for disquiet than the Electrical Trades Union. Unions have the strike weapon and it is there to use if need be. To protect their members from the consequences of temporary unemployment to some extent there must be an adequate fighting fund. In these days such a fund must be large and the E.T.U. is now in the position of having to make drastic economies although it raised its dues in October, 1954.

This is the union which was against calling off the strike. Its Communist leaders wanted to fight on although even as events have turned out the price of militancy has already been the closing of the residential training college, the closing of its convalescent home and the end of area youth conferences. Plans are being prepared for an appeal for higher dues at the September conference. There is something to command respect when a man is prepared to pawn his jacket in a good cause, but organisations must be more circumscribed in their heroics. An outcome of this kind is the result of sheer irresponsibility either in financial policy, welfare policy or strike policy—or a mixture of all three. It brings suffering to union dependents who are least able to bear it. All in all it is a grim example of the end not justifying the means.

Plan for Redundancy

Details of the scheme by the Ministry of Labour to deal with the redundancy problem arising out of the reduction in defence work were announced as this issue went to press. It is only possible therefore to emphasise the need for a carefully thought-out plan to deal with this problem. It was apparent last autumn when the motor vehicle industry was shedding labour that redundancy was a more intricate problem than had been thought. This is because the impact of redundancy on the machinery created to deal with it does not build up slowly but is immediate and severe because concerns release their unskilled and least attractive labour from the market's point of view first. The good men are the last out and by that time the problem is not one of redundancy as much as one of mass unemployment.

Redundancy is now closely allied to automation in the minds of many workers and the trade unions have had more to say about the need to avoid men being thrown out of work by new machines than on anything on the subject of automation. It would therefore be a critical situation if no tried machinery were to be available when the need to deal with redundancy on this score arose. The administrative techniques of moving men into the right industries in the right areas needs careful study and if it can be tried out on smaller problems so much the better for handling the bigger ones when they come along.

Chattering while you Work

In a thought-provoking address to the Scottish Conference of the British Institute of Management, Mr. H. P. Barker, chairman of Parkinson and Cowan, Limited, last week-end spoke on "Top Management Planning and Control." His remarks might be summarised in the borrowed phrase that the price of industrial survival is eternal vigilance. He argued, with some reasons, that full employment is here for always and that management must get used to the idea. It must take care to pick its share of available brain power and it must create conditions in which people like to work.

On the last point he said that in particular female teen-agers like to talk while they work and that production layouts (and offices as well) should take this into account. Many cases could be found of production lines which are an eternal babel of feminine conversion (and sometimes male too). Somewhere, however, it must stop. That must be where thinking as opposed to routine work takes over, where the man instead of the machine becomes the key component in the production process. Perhaps then as automation divides the labour force increasingly into thinkers (alias analysts and planners) and into routine workers, the noise on the job will be localised. The alternative is a frightening price to pay for a higher standard of living.

Morale before Money

Speaking to the Scottish Conference of the British Institute of Management on "Top Management Control and Planning," Mr. W. H. Leather, a partner in Robson Morrow and Company, emphasised the importance of non-monetary incentives. It is right that this should be done from time to time throughout the industrial hierarchy for many men are not motivated by the urge of financial gain nearly as much as at first appears. It would be easier to solve management-labour relations problems very often if it were all a question of money.

There are two reasons however why financial reward keeps raising its head. First, men are loath to take even in gross income what they consider to be remuneration which is below their market value. Prestige attaches to a large gross income even if a large part of it is syphoned off by the Inland Revenue. Then again comparative salaries and wages make money values bulk large. A man may work for something other than his wage but his attitude may change if he finds someone working near him or doing a similar job getting more than he is. Again, the executive may rate certain satisfactions almost as high as salary but if he is asked to go abroad to where the cost of living is higher he may take a different attitude—unless taxes are low. And in this case he may be anxious to go but difficult to persuade to come back. Money reward is like King Charles' head—it keeps bobbing up in all sorts of places.